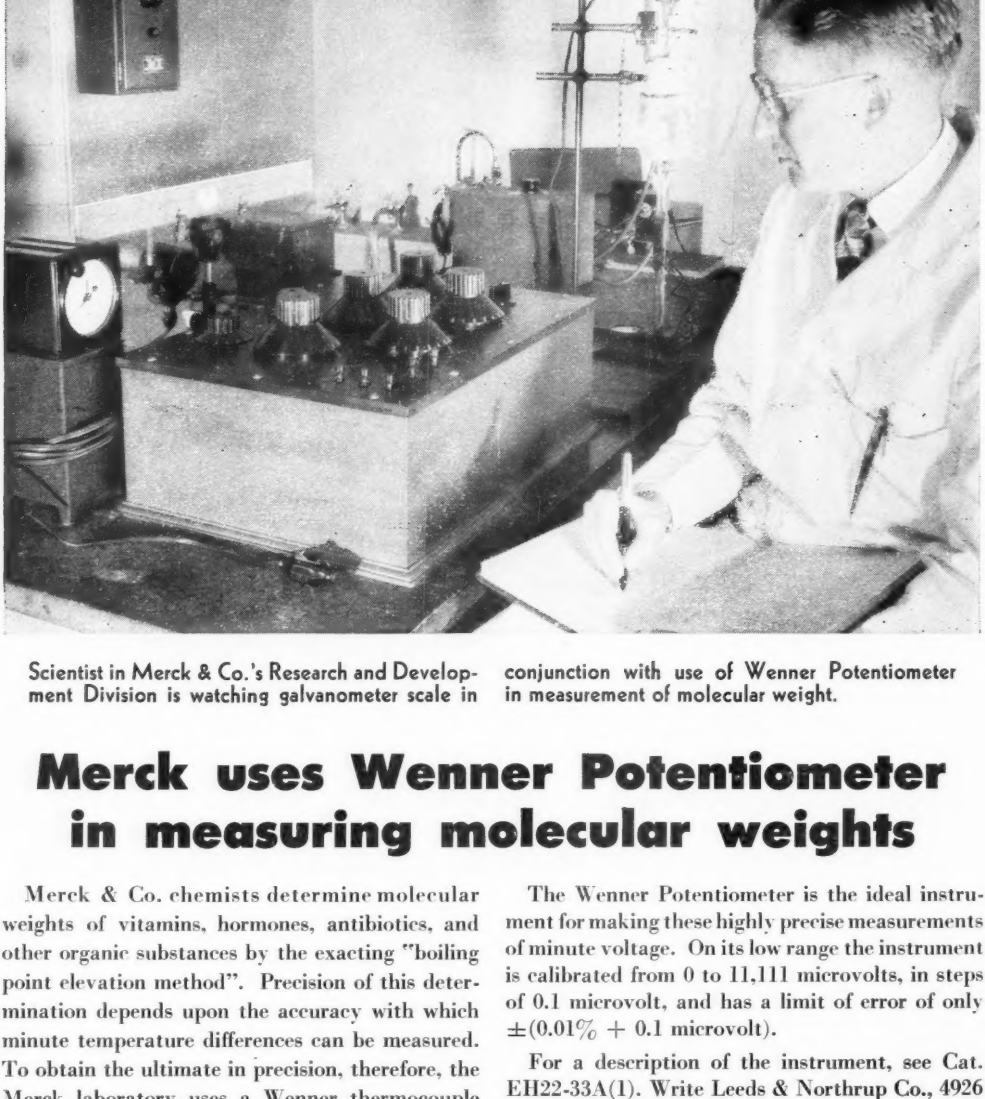
SCIENCE

FEBRUARY 24, 1950

COMPLETE TABLE OF CONTENTS ON PAGE 3

VOLUME 111, NUMBER 2778

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



Scientist in Merck & Co.'s Research and Development Division is watching galvanometer scale in conjunction with use of Wenner Potentiometer in measurement of molecular weight.

Merck uses Wenner Potentiometer in measuring molecular weights

Merck & Co. chemists determine molecular weights of vitamins, hormones, antibiotics, and other organic substances by the exacting "boiling point elevation method". Precision of this determination depends upon the accuracy with which minute temperature differences can be measured. To obtain the ultimate in precision, therefore, the Merck laboratory uses a Wenner thermocouple potentiometer. With this instrument Merck researchers obtain temperature difference measurements consistent to within ± 0.0002 C.

The Wenner Potentiometer is the ideal instrument for making these highly precise measurements of minute voltage. On its low range the instrument is calibrated from 0 to 11,111 microvolts, in steps of 0.1 microvolt, and has a limit of error of only $\pm(0.01\% + 0.1$ microvolt).

For a description of the instrument, see Cat. EH22-33A(1). Write Leeds & Northrup Co., 4926 Stenton Ave., Phila. 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad EH22-33A-242(1a)

SCIENCE

Vol. 111 No. 2878 Friday, February 24, 1950

Table of Contents

Science, a weekly journal founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Editorial and Advertising Offices, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Telephone, Executive 6060. Cable address, SCIMAG, Washington, D. C. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P.L. & R. of 1948.

Manuscripts submitted for publication should be sent to the Editorial Office, with stamped, self-addressed envelope enclosed for possible return. The AAAS assumes no responsibility for the safety of the manuscripts or for the opinions expressed by contributors.

Annual subscription, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Remittances and orders for subscriptions and single copies should be sent to the Circulation Department, *Science*, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Membership correspondence for the AAAS should be addressed to the Administrative Secretary at the same address.

Change of address. Four weeks' notice is required for change of address. This should be sent to Science Recorder, 1515 Massachusetts Ave., N.W., Washington 5, D. C. When ordering a change, it is necessary to furnish an address stencil label from a recent issue. Claims for a missing number will not be allowed if received more than 60 days from date of issue. No claims allowed from subscribers due to failure to notify the Circulation Department of a change of address or because an issue is missing from their files, or for any reason from subscribers in Central Europe, Asia, or the Pacific Islands (other than Hawaii).

The AAAS also publishes *The Scientific Monthly*. Subscription rates on request.

Mesons Produced by the Cyclotron[1]

Eugene Gardner, Walter H. Barkas,[2] F. M. Smith, and Hugh Bradner

Radiation Laboratory, Department of Physics,
University of California, Berkeley, California

THE NATURE OF THE FORCES that hold the protons and neutrons of an atomic nucleus together has interested physicists for many years. Clearly, these forces are not the same as the electrostatic forces which are ordinarily demonstrated with pith balls. Electrostatic theory would say that since protons are positively charged they should all repel one another and the nucleus should fly apart. Actually, of course, the protons and neutrons are so tightly bound together in the nucleus that it takes millions of electron volts of energy to knock one out. The exact nature of the nuclear force is not at all well understood; however, an attack on the problem has been made on the basis of the meson theory of nuclear forces as proposed by Yukawa (*33*) in 1935. According to this theory, each proton and neutron is accompanied by a "meson cloud." The mesons are thought of as being something like the quanta of an electromagnetic field, except that mesons may carry a charge and they have a finite rest mass. Nuclear forces are not explained in terms of "action at a distance" but rather by the interaction of protons and neutrons with the meson cloud.

Under some conditions it is possible to dislodge a meson from a nucleus and study it as an independent particle. Mesons as components of cosmic rays are produced when high energy particles strike atomic nuclei in the atmosphere. In the process of creating a meson, the incident particle loses a quantity of energy in the kinetic form; this quantity then reappears in the form of the rest mass energy of the meson. Mesons are produced in the same manner in the cyclotron—by bombarding a target with protons, alpha particles, or neutrons. The mesons from the synchrotron are produced when high energy x-rays strike a target. The main processes of production and decay of mesons were discovered in cosmic ray experiments,[3] but contributions are now beginning to come from experiments on mesons produced by cyclotrons and synchrotrons. In this paper we shall describe some of the methods used for detecting mesons, and some results obtained with high energy protons from the 184-inch Berkeley cyclotron.[4]

Two kinds of mesons, π and μ, have been positively identified and studied extensively. Both are unstable particles with masses intermediate between the electron mass and the proton mass. They are ordinarily studied with the same apparatus, and they frequently occur together in the same experiment. But in spite of these similarities, they are really very different types of particles. The most striking difference is that π mesons have a strong interaction with nuclei, whereas μ mesons have a weak interaction. According to present ideas, the π's are primary particles which are produced in nuclear collisions, either in cosmic rays or in accelerators. Probably all of the μ's observed in cyclotron experiments are secondary in origin, arising from the decay of the π's. Thus it is probable that it is the π mesons which are responsible for nuclear forces. There are both positively and negatively charged π mesons. Possibly there are also neutral π mesons (*4, 15, 19*), although we shall not discuss them in this paper.

When π^+ and π^- mesons decay in free space they give rise to μ^+ and μ^- mesons, respectively. This process, known as π-μ decay, will be discussed in a later section. When a μ^+ or μ^- decays in free space, it gives off a positron or an electron. The positron and electron energies indicate that in each μ disintegration two neutrinos are also given off (*18*). If π^- mesons come to rest in matter, they enter nuclei and disappear, their rest energy being transformed into nuclear excitation energy. This phenomenon is observed in photographic emulsion "stars" which occur at the ends of π^- meson tracks. The prongs of the stars are attributed to charged particles ejected from excited nuclei. The μ^- mesons seldom, if ever, make these stars (*9*). Low velocity π^+ and μ^+ mesons are prevented by electrostatic forces from entering nuclei. Thus when these positively charged mesons come to rest in matter, they decay in the same way in which they decay in free space.

[1] The work described in this paper was done under the auspices of the Atomic Energy Commission.

[2] Office of Naval Research, San Francisco.

[3] For references to original papers see "Guide to Literature of Elementary Particle Physics" (*31*). For review of both cosmic ray and artificially produced mesons, see "Mesons Old and New" (*16*).

[4] For recent experiments with mesons produced by the synchrotron, see (*22*).

Detecting Mesons Produced by the Cyclotron

The problem of detecting mesons produced by the cyclotron is one of finding a few mesons produced along with a great many more protons and other heavy particles. When mesons are produced by bombarding a target with 345-Mev protons, these "background" particles are a thousand times as numerous as the mesons. Two types of detectors well suited to this kind of problem are cloud chambers and photographic plates. With both of these devices, charged particles are studied by means of their tracks. If the background of unwanted tracks is high, one may have to look at large numbers of extraneous tracks before finding a track of the particle of interest; however, once the track is found, measurements made on it are not affected much by the presence of the other tracks. Mesons produced by the cyclotron have been detected by means of photographic plates (*12*) and also with the cloud chamber (*13*). Up to the present time, most of the work with mesons produced by the cyclotron has been done with photographic plates. This is due in part at least to the fact that the early work was done inside the cyclotron, where operation of the cloud chamber is extremely difficult. Recently, L. W. Alvarez and his associates (*2, 30*) have devised a method of detecting positive mesons from the cyclotron by means of scintillation counters. This offers a great saving in time and effort, and it is probable that counters will replace photographic plates for many meson studies.

Although the use of photographic plates as charged particle detectors has a long history,[5] the special plates now used so extensively have been produced only during the past three or four years. Some of these plates are made by the workers who use them (*10*); however, most laboratories buy their plates from manufacturers. The Ilford Nuclear Research Plates were announced (*25*) in 1946, and since that time new types of plates have appeared at frequent intervals. Similar plates, called Nuclear Track Plates, are produced by the Eastman Kodak Company, and by Kodak Limited. These special plates used for detecting charged particles have a higher concentration of silver bromide than ordinary photographic plates, and the emulsion is thicker. If a charged particle passes through the emulsion it leaves a trail of developable grains of silver bromide. When the plate is developed and viewed under the microscope, one sees a track of silver grains which shows the path of the charged particle. The silver grains have a diameter of 0.2–0.4 microns, and the track is viewed under the microscope with a magnification of from 100 × to 2000 ×, depending on the problem at hand.

One of the advantages of the photographic plate method of detecting charged particles is that plates are available with almost any sensitivity one wishes. Thus, for the study of heavily ionizing particles like

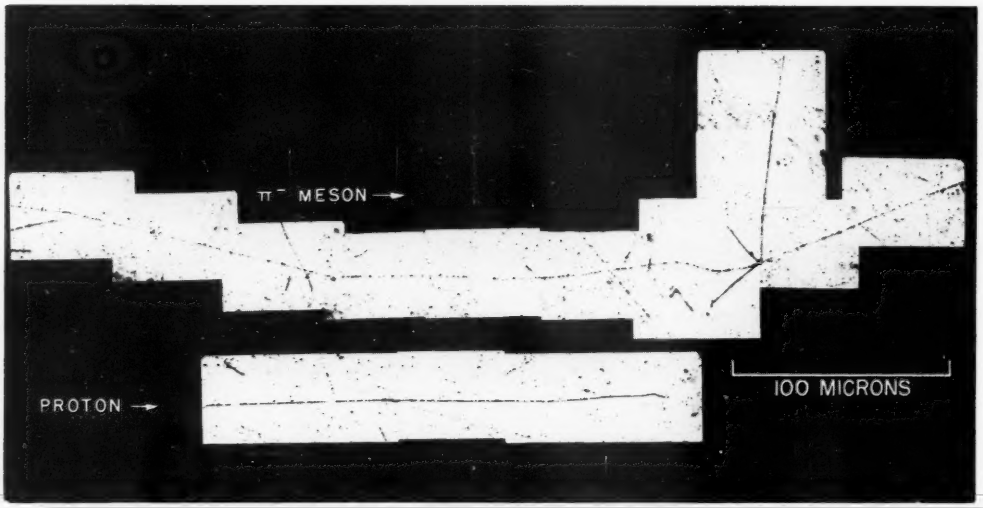


Fig. 1. *Upper*: Photomicrograph showing track of π^- meson. This meson came to rest in the emulsion and initiated a four-pronged star. *Lower*: Track of proton for comparison. Ilford C.2 emulsion. (Photomicrograph by A. J. Oliver.)

[5] For early use of photographic plates in cosmic ray studies, see reference *5*. For review of use of photographic plates, see references *26, 28, 32*.

low energy alpha particles or fission fragments, there are plates which are so insensitive that they will register only heavily ionizing particles, and the observer does not have to look at tracks of electrons or other lightly ionizing particles. On the other end of the sensitivity scale, there are plates which will register tracks of even the most lightly ionizing particles. For a quick identification of meson tracks, one uses plates like Ilford C.2 plates, which have a sensitivity such that a meson track shows a change in grain density in the last few hundred microns of the meson's range. This gives the meson track a characteristic appearance, and one can pick out the tracks by inspection. Meson tracks are further identified by a wandering, associated with small-angle scattering. This grain density change and wandering are illustrated by the meson track shown in Fig. 1. A proton track is shown for comparison. The proton track shows some scattering, but not as much as the meson track; also, the proton track has only a small rate of change of grain density. The π^- meson whose track is shown in the figure was moving from left to right. After it slowed down and stopped in the emulsion it entered a nucleus and gave up its rest energy to nuclear excitation energy. The excited nucleus then ejected four ionizing particles, which made the four tracks shown. Events of this type are called "stars."

The search for these meson tracks is rather time-consuming, and every effort is made to expose the plates in such a way that the ratio of meson tracks to background tracks will be as high as possible. Two of the arrangements which have been used for exposing photographic plates to mesons are shown in Figs. 2 and 3. The photographic plates shown in these figures are placed in position in black paper wrapping, or left unwrapped with the cyclotron enclosure darkened. As indicated in these figures, the mesons are formed when the circulating beam of 345-Mev protons strikes a target inside the cyclotron. Fig. 2 shows one arrangement for detecting π^- mesons. Those π^- mesons which leave the target in the forward beam direction are deflected by the magnetic field away from the region occupied by the circulating beam of high energy protons. Protons and heavier nuclear fragments produced at the target in the forward direction are deflected toward the center of the cyclotron because of their opposite charge, and they do not strike the photographic plate. Neutrons from the target and from other parts of the cyclotron collide with nuclei in the emulsion and produce a background of protons, alpha particles, and other nuclear fragments on the plate. The best exposures made so far have given a ratio of meson tracks to background tracks of about 1 to 50. The plates are tilted so that mesons from the target enter through the top surface of the emulsion, their trajectories making an angle of about 5° with the plane of the emulsion. A 10-second exposure

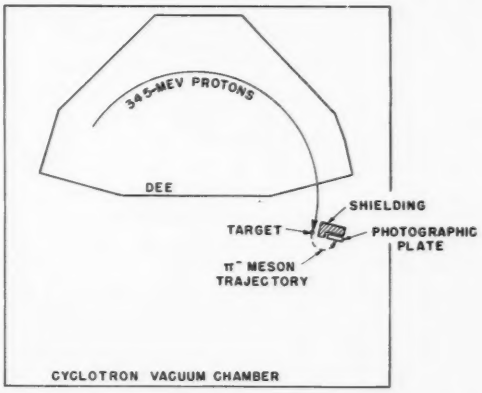


FIG. 2. Sketch of cyclotron showing arrangement for detecting π^- mesons. (Not to scale.)

gives about 1000 π^- meson tracks on one photographic plate of dimensions 1 inch by 3 inches.

One method used for detecting π^+ mesons is shown in Fig. 3. The arrangement is similar to that used for

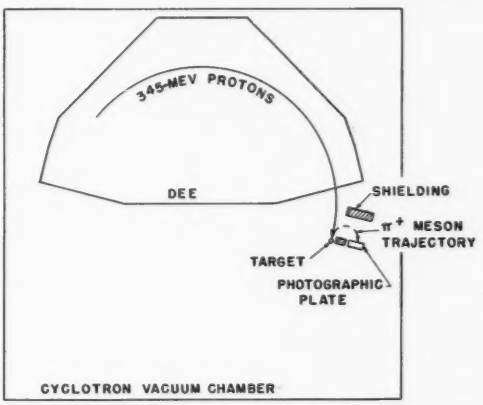


FIG. 3. Sketch of cyclotron showing arrangements for detecting π^+ mesons. (Not to scale.)

π^- mesons except that π^+ mesons which leave the target in a direction opposite to beam direction are recorded. It is true that protons and other positively charged particles from the target can follow the same trajectories as the π^+ mesons; however, the heavy particles which follow these trajectories have such a low energy and correspondingly short range that they do not interfere much with the study of the mesons.

Meson Mass Measurements

A program is now in progress in this laboratory to measure the masses of π and μ mesons. The system we are using is similar to that developed by Brode (*7*) and others in connection with mass measurements of cosmic ray mesons. By using the apparatus shown in Figs. 2 and 3 we are able to measure the momentum and range of a meson, and the determination of these two quantities is sufficient to define the mass of the meson. If the magnetic field were uniform, the trajectory would be a part of a circle, and the momentum could be found from the magnetic field intensity and the radius of curvature of the meson trajectory. The radius of curvature of the trajectory could be found from the position of the target, the position at which the meson strikes the photographic plate, and the angle the track makes with the edge of the plate. Actually, the magnetic field of the 184-inch cyclotron decreases slightly with increasing radius, so that the meson trajectory is not exactly a circle. For this case, the momentum must be found by a calculation which takes account of the field variation (*3*). The range of the meson in emulsion is found by measuring the track length under the microscope.

The equation which makes use of the momentum measurement is an exact relationship for a charged particle moving in a magnetic field.

$$E\left(1+\frac{E}{2mc^2}\right)=\frac{e^2}{2mc^2}(B\varrho)^2 \qquad (1)$$

where

E = kinetic energy of meson (ergs)
m = rest mass of meson (grams)
e = charge of meson, assumed to be equal to the charge of the electron (esu)
c = velocity of light (cm sec^{-1})
B = magnetic induction (gauss)
ϱ = radius of curvature of trajectory (cm).

The equation which uses the range measurement is an empirical relationship which has been found (*6*) to give a good representation of range-energy values in the energy region in which we are working.

$$E = k\, m^{1-n} R^n \qquad (2)$$

where

E = kinetic energy of meson (Mev)
m = rest mass of meson (in units of the proton mass)
k, n = constants determined empirically, numerical values (*16*): $k = 0.250$; $n = 0.581$.

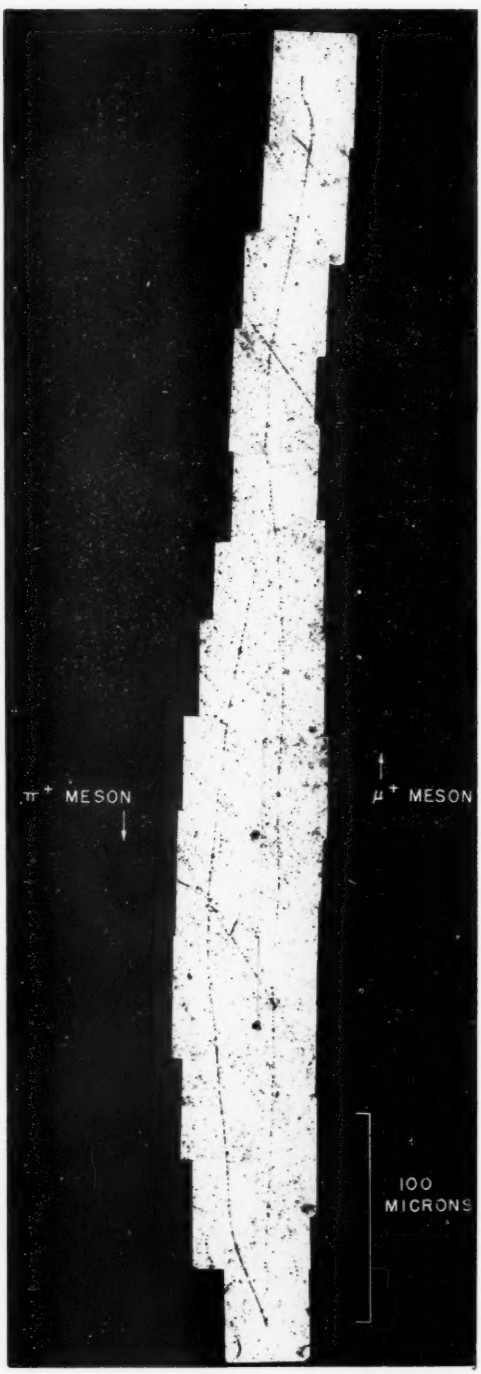


Fig. 4. Photomicrograph showing track of π^+ meson which slowed down and stopped in the emulsion and then decayed to give μ^+ meson. The μ^+ meson subsequently slows down and stops in emulsion. The μ^+ meson track has the characteristic length of about 600 microns. Ilford C.2 emulsion. (Photomicrograph by A. J. Oliver.)

By combining equations (1) and (2) it is possible to eliminate E and solve for m, the mass of the meson.

In this method of measuring meson masses, we make use of the fact that the meson trajectories start at the target. Thus the method is applicable to the measurement of masses of π^+ and π^- mesons, since these mesons are formed at the target. The π^+ mesons which come to rest in the target decay to give μ^+ mesons; thus the target is a source of μ^+ mesons which can be used for measuring the μ^+ mass. When π^- mesons come to rest in the target they are captured by nuclei; thus the target is not a source of μ^- mesons and our method is not applicable to the measurement of the μ^- mass.

We find no difference between the masses of π^+ and π^- mesons, to the accuracy with which we have made the measurements. Preliminary mass values are (*20*)

$$m_\pi = (276 \pm 6)\ m_e$$
$$m_{\mu^+} = (210 \pm 4)\ m_e$$

where m_e is the mass of the electron. These values were found by applying equations (1) and (2) as described above. A new measurement is now in progress in which meson masses are found by comparison with the proton mass. It is thought that this method will give more accurate values; however, no results from this new measurement are yet available.

π-μ Decay

One of the most interesting facts connected with the meson decay process is that all μ^+ mesons coming from the decay of π^+ mesons at rest seem to have the same energy, about 4 Mev. This was first found in experiments with cosmic rays (*17*) and was later verified in cyclotron experiments (*8*). When π^+ meson tracks are observed to end in Ilford C.2 plates, or plates of greater sensitivity, it is found that a μ^+ meson begins at the point at which the π^+ track ends. If the μ^+ meson remains in the emulsion for its entire range, the track always has a length of about 600 microns, except for some variation attributed to straggling, i.e., variation due to the statistical nature of the energy loss process. It is seen from equation (2) that this range corresponds to an energy of about 4 Mev. An example of a π-μ decay as recorded in Ilford C.2 emulsion is shown in Fig. 4.

The fact that μ mesons from π-μ decay always have the same kinetic energy is a very strong indication that one and only one other particle is given off in the disintegration. This other particle does not leave an observable track, even in the most sensitive emulsion, so that it is thought to be an electrically neutral particle. From the mass values given in the preceding section, it is seen that the μ meson is about 66 electron masses lighter than the π meson. This mass difference is equivalent to about 34 Mev of energy, of which 4 Mev is accounted for as kinetic energy of the μ meson. It is assumed that the neutral particle carries off the remaining 30 Mev of energy, and enough momentum to balance that received by the μ meson. Calculations show that these conditions are satisfied if the neutral particle has zero rest mass.

The Lifetime of the π Meson

The lifetime of the π meson is so short that some of the mesons undergo π-μ decay before they reach the position of the plates shown in Figs. 2 and 3. If the mesons were not intercepted by the plates but were allowed to continue in approximately circular orbits, they would make, on the average, only about two revolutions before they decayed. Richardson (*27*) and Martinelli and Panofsky (*21*) have made measurements of the π meson lifetime by observing how many mesons disappear from a group of mesons in the time required for the group to travel through one revolution. The schematic diagram of the arrangement is shown in Fig. 5. One group of mesons, *A*, spirals upward and strikes the top photographic plate after traveling one half-revolution. A second group, *B*, spirals downward and travels for one and one-half revolutions before striking the bottom plate. Suitable shielding (not shown) prevents mesons from reaching the plates by any paths other than the ones shown. Numbers of mesons striking the two plates are found by counting meson tracks after the plates are developed. After appropriate geometrical corrections are made, the lifetime of the mesons is found from the number lost from Group *B* in the time required to travel the extra revolution.

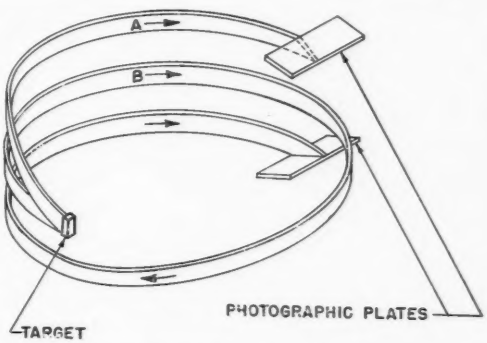


FIG. 5. Sketch of target and plates showing one group of mesons, *A*, which travels through one half-revolution and another group, *B*, which travels through one and one-half revolutions. (Not to scale.)

Richardson (*27*) worked with π^- mesons and ob-

tained a value of $\left(1.11\frac{+.31}{-.22}\right)\times10^{-8}$ sec for the mean life. Martinelli and Panofsky (*21*), working with π^+ mesons, found a mean life of $\left(1.97\frac{+.14}{-.17}\right)\times10^{-8}$ sec. The values given are not in agreement within the errors quoted; however, this discrepancy is not interpreted as proving that the mean life of the π^- meson is really different from that of the π^+ meson.

The mean life of the μ meson, as found in cosmic ray experiments, is larger than that of the π meson by a factor of about a hundred. The value of the mean life of the μ^+ meson is given by Nereson and Rossi (*23*) as $(2.15\pm0.07)\times10^{-6}$ sec.

Stars Initiated by π^- Mesons

The photographic emulsion stars initiated by π^- mesons exhibit a wide variation. They differ in the number of prongs per star, in the orientation of the prongs, and in the types and energies of the particles making the prongs. The prong-number distribution has attracted interest as an aid in the study of the mechanism by which the π^- meson gives up its rest energy to a nucleus (*11, 20, 24*), and as a method of finding out how many π^- meson tracks are present in a mixture of tracks which includes some μ meson tracks. As shown in the prong distribution table which follows shortly, some of the π^- meson tracks are not accompanied by stars, and there is no simple way to distinguish these tracks from tracks of μ mesons. If the prong-number distribution is known, however, the number of star-forming mesons can be counted, and the appropriate number added for those which do not make stars. This method has been used by McMillan, Peterson, and White (*22*) to find the ratio of π^- to π^+ mesons produced by x-rays from the 335-Mev Berkeley synchrotron.

In order to find the prong-number distribution of stars initiated by π^- mesons, it is important to have a group of π^- mesons free from contamination of other types of mesons. With the apparatus arranged as shown in Fig. 2, only mesons with a negative charge can reach the photographic plate. In addition to the π^- mesons, however, there will be some μ^- mesons which come from the decay-in-flight of the π^- mesons. By applying the method we have described, one can make a mass measurement for each individual meson. The measured masses of the π^- mesons will form a group whose average value is approximately 276 electron masses, but the μ^- mesons will not, in general, have ranges and momenta such that they could be confused with this group. Prong-number distribution studies can be done with the same mesons used for mass measurements.

The prong-number distribution as found from 512 stars initiated by π^- mesons is given by Adelman and Jones (*1*) as follows:

Number of prongs (includes recoils)	Percent of stars having this number of prongs
0	28.8
1	21.5
2	27.0
3	15.2
4	7.8
5	1.8
6 or more	None found in this study

Yield of π Mesons as a Function of Bombarding Energy

The number of mesons produced by bombarding a target with protons increases rapidly as the proton energy is increased. A convenient method for studying this effect is to move the target and plate shown in Figs. 2 and 3 to different radii in the cyclotron. In this way one can observe the yield of mesons as a function of proton energy from energies as small as desired up to 345 Mev, the maximum proton energy available from the cyclotron. If a carbon target is used, the integrated beam current can be obtained by observing the positron activity of the C^{11} formed in the $C^{12}(p,pn)C^{11}$ reaction. The relative meson yields at the various energies are found by counting meson tracks on the photographic plates. Appropriate corrections are made for integrated beam currents and relative volumes of emulsions scanned.

So far, meson yields have been measured only for mesons of energy 2–10 Mev. In a study by Jones and White (*14*) the relative yields were measured for π^- mesons produced by bombarding a 1/32-inch carbon target with protons. Their results are as follows:

Proton energy (Mev):	345	305	270	235	200	165
Relative yield:	100%	47%	22%	8%	1%	0%

These results are of interest to workers planning the construction of accelerators which might be used for meson studies.

This is the first of two papers on the subject of mesons produced by the cyclotron. The second paper, by Chaim Richman and Howard Wilcox, describing experiments with mesons produced outside the cyclotron by the deflected proton beam, will be published in a later issue of Science.

References

1. ADELMAN, FRANK L. and JONES, STANLEY B. *Science*, 1950 to be published.
2. ALVAREZ, L. W. *et al.* *Bull. Amer. phys. Soc.*, 1949, **24**, 20.
3. BARKAS, W. H. *Bull. Amer. phys. Soc.*, 1949, **24**, 13.
4. BJORKLUND, R. *et al.* *Phys. Rev.*, 1950, **77**, 213.
5. BLAU, M., WAMBACHER, H. *Nature*, Lond., 1937, **140**, 585.
6. BRADNER, H. *et al.* *Phys. Rev.*, to be published.
7. BRODE, R. B. *Rev. mod. Phys.*, 1949, **21**, 37.
8. BURFENING, J., GARDNER, E., and LATTES, C. M. G. *Phys. Rev.*, 1949, **75**, 382.
9. CHANG, W. Y. *Rev. mod. Phys.*, 1949, **21**, 166.
10. DEMERS, PIERRE. *Science*, 1949, **110**, 380.
11. FUJIMOTO, Y., HAYAKAWA, S., and YAMAGUCHI, Y. *Prog. Theo. Physics*, in press.
12. GARDNER, E. and LATTES, C. M. G. *Science*, 1948, **107**, 270.
13. HARTSOUGH, W., HAYWARD, E., and POWELL, W. M. *Phys. Rev.*, 1949, **75**, 905.
14. JONES, S. B. and WHITE, R. S. *Phys. Rev.*, in press.
15. KAPLON, M. F., PETERS, B., and BRADT, H. L. *Phys. Rev.*, 1949, **76**, 1735.
16. KELLER, JOSEPH M. *Amer. J. Phys.*, 1949, **17**, 356.
17. LATTES, C. M. G., OCCHIALINI, P. S., and POWELL, C. F. *Nature*, Lond., 1947, **160**, 453, 486.
18. LEIGHTON, R. B., ANDERSON, C. D., and SERIFF, A. J. *Phys. Rev.*, 1949, **75**, 1432.
19. MARSHAK, R. E. *Phys. Rev.*, 1949, **76**, 1736.
20. ———. Echo Lake Cosmic Ray Conference, June 22–28, 1949.
21. MARTINELLI, E. and PANOFSKY, W. *Phys. Rev.*, to be published.
22. MCMILLAN, E. M., PETERSON, J., and WHITE, R. S. *Science*, 1949, **110**, 579.
23. NERESON, N. and ROSSI, B. *Phys. Rev.*, 1943, **64**, 199.
24. PERKINS, D. H. *Phil. Mag.*, 1949, **11**, 601.
25. POWELL, C. F. *et al.* *J. sci. Instr.*, 1946, **23**, 102.
26. POWELL, C. F. and OCCHIALINI, G. P. S. *Nuclear physics in photographs.* Oxford: Clarendon Press, 1947.
27. RICHARDSON, J. R. *Phys. Rev.*, 1948, **74**, 1720.
28. SHAPIRO, M. M. *Rev. mod. Phys.*, 1941, **13**, 58.
29. SMITH, F. M. *et al.* *Bull. Amer. phys. Soc.*, 1949, **24**, 9.
30. STEINBERGER, J. and BISHOP, A. S. *Bull. Amer. phys. Soc.*, 1950, **25**, 11.
31. TIOMNO, J. and WHEELER, JOHN A. *Amer. Sci.*, 1949, **37**, 202, 417.
32. YAGODA, H. *Radioactive measurements with nuclear emulsions.* New York: John Wiley and Sons, 1949.
33. YUKAWA, H. *Proc. phys. math. Soc. Japan*, 1935, **17**, 48.

The Cooperative Committee for the Teaching of Science:[1] A Report to the AAAS Council, December, 1949

K. Lark-Horovitz

Purdue University, Lafayette, Indiana

A SMALL DELIBERATIVE COMMITTEE was set up in 1941, sponsored by five scientific societies representing biology, chemistry, mathematics, physics, and research in science teaching,[2] to consider problems of science in general education that no single organization can solve alone. The committee is known as the Cooperative Committee on Science Teaching. Most of its original members were members of college or university faculties, and their affiliations were with learned societies. In general, the committee represented the point of view of college and university men on problems of science in general education. There were also members working on the secondary school level, but

[1] Present membership: American Association of Physics Teachers (K. Lark-Horovitz, Purdue University, Glen W Warner, Lakeville, Indiana); American Astronomical Society (Ralph C. Huffer, Beloit College); American Chemical Society (C. H. Sorum, University of Wisconsin); American Institute of Physics (K. Lark-Horovitz, Purdue University); American Society of Zoologists (L. V. Domm, University of Chicago); Botanical Society of America (Glenn W. Blaydes, Ohio State University); Central Ass'n. of Science and Math. Teachers (Arthur O. Baker, Cleveland Board of Education); Division of Chemical Education of the American Chemical Society (Laurence L. Quill, Michigan State College); Executive Committee of the AAAS (E. C. Stakman, University of Minnesota); Geological Society of America; Mathematical Association of America (Raleigh Schorling, University of Michigan); National Association of Biology Teachers (Prevo L. Whitaker, Indiana University); National Association for Research in Science Teaching (George Mallinson, Western Michigan College of Education); National Council of Teachers of Mathematics (J. R. Mayor, University of Wisconsin); National Science Teachers Association (Morris Meister, Bronx High School of Science); Section Q. Education, AAAS (B. L. Dodds, Purdue University); U. S. Office of Education (Bernard B. Watson, U. S. Office of Education). Chairman, K. Lark-Horovitz, Physics Department, Purdue University. Secretary, R. W. Lefler, Physics Department, Purdue University.

[2] American Association of Physics Teachers (K. Lark-Horovitz, Purdue University, Glen W. Warner, Wilson Junior College, Chicago); American Chemical Society (B. S. Hopkins, University of Illinois, Martin V. McGill, Lorain High School, Lorain, Ohio); Mathematical Association of America (A. A. Bennett, Brown University, Raleigh Schorling, University of Michigan); National Association for Research in Science Teaching (G. P. Cahoon, Ohio State University, Robert J. Havighurst, University of Chicago); Union of Biological Societies (Oscar Riddle, Carnegie Station for Experimental Evolution, Walter F. Loehwing, State University of Iowa); Robert J. Havighurst, chairman; Glen W. Warner, secretary.

they were in the minority. Financed by a small grant from the Carnegie Foundation, the committee considered primarily four problems. They were: (1) licensing or certification of secondary school science teachers; (2) college training of prospective science teachers; (3) exploratory studies of the secondary school science curriculum; and (4) curriculum projects in the state of Indiana.

In 1944, with the expiration of the Carnegie Foundation grant, the committee decided to reorganize on a new basis, with a new and expanded membership. Representatives from geology, astronomy, and applied biological fields (agriculture), as well as some of the secondary school teachers' organizations, were considered, and the committee asked the Executive Committee of the AAAS to appoint it as an agency of the Association. In this proposal (February 1945) the committee, formulating its plans and functions, pointed out that as such an agency it could give the sections of the Association and their affiliated societies a chance to coordinate their interest in science education. It could bring the Association to the attention of science teachers. And it could help to arrange public meetings at the time of the AAAS meetings, designed to draw a large attendance of teachers from the area in which the meeting is held, and help the Association to make an appeal to teachers, as the British Association has done so successfully.

The committee also pointed out that it could provide a forum in which representatives of scientific societies could state the views of their own groups and learn about the views of other groups on science teaching. It could serve its parent organization as a clearinghouse for information, and as a source of stimulation with reference to science education, and report to it regularly through its representatives on the committee. It would also be in a position to work cooperatively, upon request, with other organizations.

As to representation, the committee suggested that it should judge its own needs for new members and follow in general the principle that the number of representatives in a given science area would not exceed three. Membership would be from 15 to 20. The principle of such representation is not to protect interests but to insure an adequate representation of various points of view. The parent organization would name the representative for terms of several years, the exact term to be decided by the organization. This would result in a fair degree of continuity of membership without too much rigidity. The parent organization would be expected to select as representatives persons who had shown special interest in science education, both elementary and secondary.

The committee would organize itself, electing its own officers, to insure its continuous activity. However, the Executive Secretary of the AAAS would have the power to call a meeting of the committee whenever a year passed without the committee's having met. The parent organization should provide for the travel expenses of its own representatives who attended the committee meeting. The small overhead expenses for incidentals should be cared for from other sources—possibly the institution with which the chairman is associated.

In case the committee should engage in projects requiring money for research or publications, such funds should be solicited explicitly for the project alone. Thus the parent organization would not be obligated beyond providing for the attendance at the meeting of its own representatives. Ordinarily the committee would be expected to meet twice a year, one meeting to coincide with the annual meeting of the AAAS, facilitating contact of the committee with the parent organization. Thus one meeting at a time, relatively free from conflict with other meetings, would permit intensive work by committee members.

The committee, as a working group, would need continuity of attendance. The parent organization should consider this in naming representatives.

When the committee's proposal was received, Otis W. Caldwell was chairman of a Committee for the AAAS on The Place of Science in Education, and as a consequence, the negotiations for the reorganization of the committee were carried on primarily through Dr. Caldwell and E. C. Stakman, as representing the AAAS Executive Committee. The discussions of the Executive Committee in the late fall of 1944 had indicated the interest of the Association in the type of work the committee was engaged in. As to the organization, a very liberal attitude was taken:

> Attention was called to the fact that several members of the Committee are not members of the AAAS. That is not essential to our cooperation. We should welcome all of them as members if they care to join the Association. Please understand that we shall cooperate regardless of whether the members of the Committee are members of AAAS.[3]

The proposal was accepted by the Executive Committee of the AAAS in March, 1945 and it was moved that there be appointed a AAAS Cooperative Committee on the Teaching of Science. The motion included a request that in the reorganization at least half of the old committee should continue for at least one year on the new committee, in order to set up plans and guide those plans in terms of the lines of procedure already engaged in.

The Executive Committee expressed very definitely the thought that it was best to have the new organization appointed as a committee of the AAAS, not

[3] Letter of Dr. Caldwell to R. J. Havighurst, then chairman of the committee.

raising the question of the precise nature of affiliation or association.

It is of interest to note that as early as 1944, the Committee on the Professional Training of Chemists had recommended that "all of the societies' efforts to improve the teaching of chemistry in secondary schools be limited to the Cooperative Committee, and such central agencies as have been chosen by the Cooperative Committee."[4]

The Bibliography by the Cooperative Committee Reports gives an outline of the committee's activities. It has fulfilled its function to provide a forum for the discussion of science teaching, starting with the St. Louis meeting of the AAAS, and has repeated these forums at consecutive meetings of the Association.

In 1946, the committee joined in an effort with a committee of the National Science Teachers Association to report on science course content and teaching apparatus used in U. S. schools and colleges. This report was submitted to the ministers of education of the devastated countries of the United Nations. The Cooperative Committee prepared the college material and participated in an advisory capacity in the preparation of the entire report.

The committee undertook its biggest task in participating in the report by the President's Scientific Research Board, "On the Present Effectiveness of Our Schools in the Training of Scientists." This report appeared in Vol. 4 of *Manpower for Research*.

In the preparation of this report it became clear to the members of the committee that the problem of science in general education extends beyond the elementary and secondary school levels and also beyond the undergraduate level. As a consequence, the committee asked permission from the parent organization to extend its activities to a consideration of general education in science at the college level. This permission was granted and the first effort in this respect was the sponsoring of a Ph.D. thesis at Northwestern University, by R. A. Bullington, on "A Survey of the Present Status of the Science Teaching in General Education in the Colleges and Universities of the Country." About a thousand schools were approached and answers were received from about 65 percent regarding staff, course content, student and faculty reactions, and teaching procedures.

Dr. Bullington's report made it plain that a program of evaluation of the achievements of science courses in general education is of the utmost importance. As a consequence, the committee is now discussing the advisability of evaluation programs.

To bring the recommendation of the various committee reports to the attention of local and state groups, suggestions for an implementation program have been worked out and will be circulated among professional and teaching societies.

The committee also felt that it was necessary to have a member representing the U. S. Office of Education. Discussions with Commissioner McGrath and his staff resulted in the appointment of Bernard B. Watson, of the Division of Higher Education to the Committee, to act as liaison between the U. S. Office of Education and the Cooperative Committee.

At the 1949 meeting of the AAAS, the committee sponsored three symposia. The first, on "Trends in Research," brought selected topics of research to the attention of teachers for use in their classes; the second was a discussion of "The Program of Science in General Education"; and the third, a panel discussion on "The Improvement of Science Teaching at the College Level."

The committee has cooperated with all the teaching societies in setting up a unified program. Twenty thousand copies of the printed program have been issued to teachers all over the nation—a distribution made possible by the generosity of the Welch Scientific Company.

In this way we hope to fulfill some of the functions which the committee anticipated upon its reorganization—namely, to bring to the attention of the public the abiding interest of the AAAS, not only in scientific research, but in the teaching of science.

Bibliography of Papers and Reports Prepared by the AAAS Cooperative Committee on the Teaching of Science and Mathematics

"The Preparation of High School Science Teachers." A Preliminary Report of the Cooperative Committee on Science Teaching. *School Science and Mathematics*, October, 1942, pp. 636–50.

"High School Science and Mathematics in Relation to the Manpower Problem." A Report of the Cooperative Committee on Science Teaching, *School Science and Mathematics*, February, 1943, pp. 127–57.

"Science and Mathematics in Educational Programs for Returning Service Men and Women." Recommendations by the Cooperative Committee on Science Teaching. *School Science and Mathematics*, June, 1944, pp. 517–20.

"The Preparation of High School Science and Mathematics Teachers." Report No. 4, the AAAS Cooperative Committee on Science Teaching, *School Science and Mathematics*, February, 1946, pp. 107–18.

"Problems of the Science Teacher." A Forum presented by the AAAS Cooperative Committee in December, 1946: "Reflections on Science and Liberal Education," Laurence L. Quill; "The Laboratory Problem of the Science Teacher," Morris Meister; "Recruiting and the Economic Status of the Science

[4] Personal communication to R. J. Havighurst by B. S. Hopkins.

Teacher,'' Raleigh-Schorling, ''The Necessity of Science Legislation,'' K. Lark-Horovitz; and ''Resume,'' A. J. Carlson. *The Science Teacher,* February and April, 1947.

''The Effectiveness of Science Teaching,'' A Forum presented by the AAAS Cooperative Committee in December, 1947: ''Why the Report on the Effectiveness of Science Teaching was Needed,'' Philip N. Powers; ''Science in Elementary and Secondary Education,'' Morris Meister; and ''Mathematics—Grades One to Twelve,'' Raleigh Schorling; ''The Effectiveness of Our Schools in the Teaching of the Biological Sciences,''[5] Glenn W. Blaydes and L. V. Domm; ''The Effectiveness of the Teaching of the Physical Sciences,'' Lloyd W. Taylor; and ''Science Teaching Today,'' K. Lark-Horovitz. *The Science Teacher,* February and April, 1948.

''Problems of Science and Mathematics in General Education,'' A Forum presented by the AAAS Cooperative Committee in November, 1948: ''Teaching Science for General Education in the Secondary School,'' G. P. Cahoon; ''Problems of Biology in General Education,'' Prevo L. Whitaker; ''Mathematics in General Education,'' Raleigh Schorling; and ''The Physical Sciences in General Education,'' C. H. Sorum. *School Science and Mathematics,* April, 1949.

''The Cooperative Committee on the Teaching of Science and Mathematics—Its Organization and Program.'' *Science,* July 11, 1947, pp. 28–30.

''Science Course Content and Teaching Apparatus used in the Schools and Colleges of the United States.'' Prepared jointly by a committee on the National Science Teachers Association and the AAAS Cooperative Committee for submission to the Ministers of Education of the Devastated Countries of the United Nations. The Cooperative Committee prepared the college material pp. 51–186 and participated in an advisory capacity in the preparation of the entire report.

''The Present Effectiveness of our Schools in the Training of Scientists.'' The AAAS Cooperative Committee on the Teaching of Science and Mathematics. Appendix II, pp. 47–149. *Manpower for Research,* Vol. IV, *Science and Public Policy,* A Report to the President by The President's Scientific Research Board.

[5] *Ibid.,* with slight modification. *The American Biology Teacher,* 1949, **11**, 10.

''Cooperative Committee on Science Teaching.'' *Journal of Chem. Educ.* (news notes) Vol. 19, p. 70, Feb. 1942.

''Cooperative Committee on Science Teaching.'' *Journal of Chem. Educ.* (news notes) Vol. 19, p. 562, Dec. 1942.

''Report of the Committee.'' *School Science and Mathematics.* Oct. 1942.

Lark-Horovitz, K., ''On the Preparation and Certification of Teachers of Secondary School Science.'' *Am. Jr. of Physics.,* Vol. 11, p. 41, Feb. 1943.

Havighurst, R. J. and Lark-Horovitz, K., ''The Schools in a Physicist's War.'' *Am. Jr. of Physics,* Vol. 11, p. 41, Feb. 1943.

Hopkins, B. S., ''Study Problem of the Teaching of Chemistry in the High Schools.'' *Chem. and Eng. News,* Vol. 21, p. 676, May 10, 1943.

Statement of Cooperative Committee to Board of Directors of American Chemical Society on problems of Secondary School Teaching of Chemistry. *Chem. and Eng. News,* Vol. 22, p. 596, Apr. 25, 1944.

Committee on Geological Education of the Geological Society of America. (References refer to work of the committee.) Interim Proceedings of the Geological Society of America: Part 2, Report of March 1946; Part 4, Report of June 1946; Part 5, Report of July 1946; Part 1, Report of March 1947; Part 2, Report of March 1948.

Schorling, R., ''A Program for Improving the Teaching of Science and Mathematics.'' *Am. Mathematical Monthly,* Vol. 55, No. 2, Apr. 1948.

''Science Courses in General Education.'' *Higher Education,* Vol. 6, p. 78, Dec. 1, 1949.

''Science Courses in General Education.'' *Am. Jr. of Phys.,* Vol. 17, p. 526, Nov. 1949.

''Science Teaching Symposium.'' *Chem. and Eng. News,* 1949, Vol. 27, p. 3508, Nov. 21.

Riddle, Oscar, ''The Preparation of High School Science Teachers.'' *The American Biology Teacher,* 5, 63–65, 1942.

''Deficient Instruction in Biology in High Schools,'' unsigned editorial by Oscar Riddle. *Journal American Medical Association,* 125, 356–7, 1944.

Riddle, Oscar, ''Education for *All* American Youth'' (from the point of view of a biologist), *School and Society,* 61, 113–16, 1945.

Lee, Oliver J., ''The Teaching of Science and Mathematics.'' *Popular Astronomy,* 54, 382–4, 1946.

Technical Papers

Macromolecular Arrangement within Muscle

Councilman Morgan, George Rozsa,[1] Albert Szent-Györgyi[1] and Ralph W. G. Wyckoff

Laboratory of Physical Biology, Experimental Biology & Medicine Institute, National Institutes of Health, Bethesda, Maryland

Electron microscopy has already given much information about the macromolecular components of striated muscle (*1, 4*). Thus it is shown that myofibrils of teased muscle are ribbons composed of parallel arrays of filaments associated with an amount of seemingly amorphous material that is greatest in the anisotropic regions.

For the present work, strips of psoas muscle separated from a rabbit at death were tied *in situ* to strips of wood at their resting length, then cut out and immediately fixed in formalin. Pieces of this fixed muscle were dehydrated by passage through alcohols, embedded in methacrylate, and thinly sectioned for electron microscopy by the procedures recently outlined by Neumann, Borysko and Swerdlow (*2*) and finally shadowed with gold-Manganin.

In favorable instances an astonishingly regular macromolecular arrangement can be seen in these sections. At a moderate magnification a section of a fiber cut nearly at right angles to the long axis will appear as in Fig. 1. The macromolecular filaments constituting the myofibrillar blocks are seen almost end-on as either dots or short rods. Their diameters correspond to those of the fila-

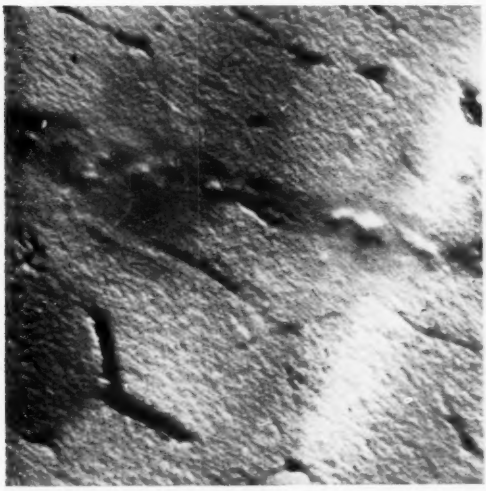


FIG. 1. A transverse section through a muscle fiber nearly normal to the fiber axis showing several myofibrils. Magnification, × 30,000.

FIG. 2. A transverse section through muscle at a higher magnification. Magnification, × 50,000.

Though the study of such teased preparations has much to say about the macromolecular structure of muscle, it does not and cannot be expected to tell much about the relation between these thin strips or ribbons and the way they are built up in three dimensions in the intact myofibrils. This can be done only by the investigation of transverse and longitudinal sections. We are here reporting certain preliminary results of such an investigation.[2]

ments seen in electron micrographs of teased preparations. The order that is obvious in the arrangement of these macromolecules is clear at the higher magnification of Fig. 2. The section here is almost exactly normal to the fiber axis, the molecular net is approximately hexagonal, and therefore the filaments must be fairly close-packed in the fiber itself.

Longitudinal sections also have shown regularity in particle arrangement (Fig. 3). The macromolecular filaments, which run nearly vertical in this figure, have an obvious beaded structure and the beads of adjacent filaments are regularly aligned to give a net which might be rectangular if the section were cut exactly parallel to the fiber axis. The existence of such a net in longitudinal section, together with the hexagonal net seen in transverse

[1] Public Health Service Special Research Fellow of the Experimental Biology and Medicine Institute.

[2] Electron micrographs recently published (*3*) of sectioned rat muscle have been interpreted to mean that the intact myofibril is a hollow cylinder or tube of which the teased-out ribbon is the shell or outer layer. As the accompanying photographs demonstrate, our results do not point to such a structure.

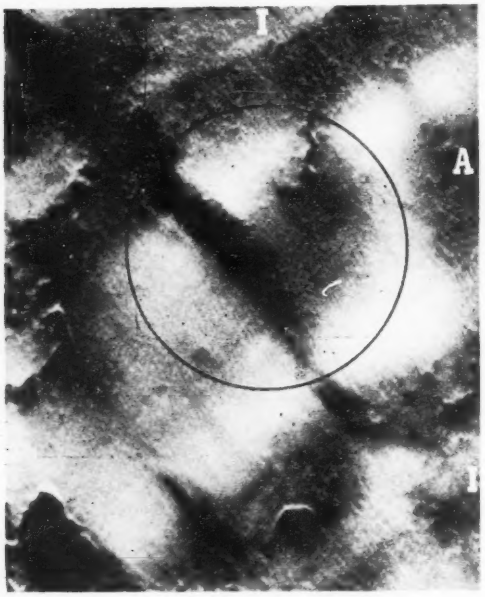


FIG. 3. A longitudinal section through part of a muscle fiber. Regions adjacent to I and A correspond to isotropic and anisotropic bands. Order in particle arrangement is best preserved in regions enclosed by the inked-in circle. Magnification, × 27,250.

section, demonstrates that there is three-dimensional, and by definition crystalline, order in the arrangement of the macromolecular components of the fibrils of this striated muscle. The regularity is most pronounced in the anisotropic bands.

An awareness of this high degree of order in its structure is obviously important for an understanding of muscle and of the way it functions. We are continuing this investigation to find out more about the nature and fine structure of the particles which display this order and to see how they are changed by muscular contraction.

References

1. HALL, C. E., JAKUS, M. A., and SCHMITT, F. O. *Biol. Bull.*, 1946, **90**, 32.
2. NEUMANN, S. B., BORYSKO, E., and SWERDLOW, M. *Science*, 1949, **110**, 66.
3. PEASE, D. C. and BAKER, R. F. *Amer. J. Anat.*, 1949, **84**, 175.
4. ROZSA, G., SZENT-GYÖRGYI, A., and WYCKOFF, R. W. G. *J. cell. Res.*, **1**, in press.

Synthesis of Greatly Enriched HD

Francis J. Norton

General Electric Research Laboratory
Schenectady, New York

The maximum concentration of the hydrogen-deuterium molecule HD which can be obtained in the equilibrium mixture is approximately 50%. The equilibrium constant for the reaction $H_2 + D_2 = 2HD$ has been determined (*5*, *12*) and is near 4, which would be expected from random distribution of the three molecular species.

In making studies of the boron hydrides, I have found a method by which HD of 85% concentration can readily be prepared. The residual gases are H_2 and D_2.

The synthesis consists in direct complete deuteration of B_2H_6 by D_2, and slow reaction of the B_2D_6 with H_2O, producing HD. The reactions were followed and the gases analyzed by a mass spectrometer operated as has been described (*11*).

One other note of direct synthesis of HD was found. H. Beutler *et al.* (*2*) reacted LiH with D_2O, and used the ultraviolet absorption between 750 and 850 A to determine H_2, D_2, and HD. They report enrichment in HD above the equilibrium amount.

The first step in the B_2H_6 method is deuteration using D_2 gas obtained from the Isotopes Branch, U. S. Atomic Energy Commission. The deuteration proceeds slowly at room temperature, in a pyrex bulb, without catalyst. Equilibrium is attained in 1½ hr at 80° C, with only a small amount of thermal decomposition of the B_2H_6. Successive amounts of D_2 must be added, for the deuteration at each stage is only partial. This is due to the accumulation of H_2 removed from the B_2H_6 molecule in the process. After each stage in the deuteration, liquid N_2 was used to condense the B_2H_6-B_2D_6, the H_2-diluted D_2 was pumped away, and fresh pure D_2 was added. About seven stages, with large excess pressure of D_2 over B_2H_6 in each, produces B_2D_6 of purity greater than 95%, and further additions of pure D_2 give no further change in the mass spectrum of the B_2D_6.

The progress of deuteration was followed by the mass spectrometer. At complete deuteration, the ratio of mass peaks 32 to 31 is very close to 2.0. These peaks represent the ions $B^{11}B^{11}D_5$ and $B^{10}B^{11}D_5$. These values are to be expected from an abundance ratio of boron $B^{11}/B^{10} = 4.0$. This is in agreement with the value found at the National Bureau of Standards (*4*). The ratio of the parent ion, $B^{11}B^{11}D_6$ at mass 34 to the ion $B^{11}B^{11}D_5$ at mass 32 was found to be under 1%, even smaller than is the case with the parent ion for normal B_2H_6 and $B_2{}^{10}H_6$ (*3*, *11*).

The second step in producing highly enriched HD is to react the pure B_2D_6 slowly with low concentration of H_2O over H_2SO_4 at 25° C.

Into a 63-cc pyrex bulb, 5 ml of H_2SO_4, sp. gr. 1.752 (20° C) was placed. This is 82.8% H_2SO_4. It produces a water vapor pressure of about 0.06 mm at 25° C. The mass spectrometer showed no detectable SO_2 or SO_3 in the gas phase at this temperature. The acid was degassed by alternate freezing and thawing, and pure B_2D_6 con-

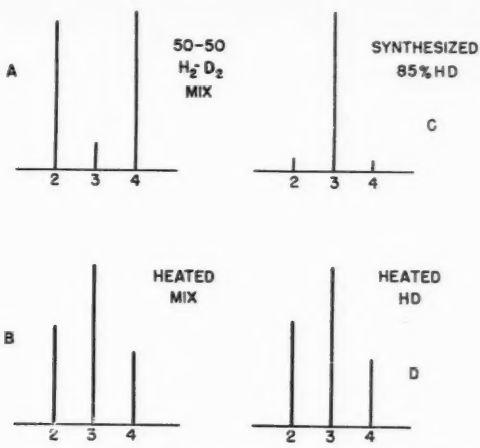


FIG. 1. Mass spectra before and after equilibration by heating on Ni filament. A, B, 50–50 mixture of H_2 and D_2. C, D, synthesized HD, initially 85%.

densed in the bulb by liquid N_2. The bulb was closed and warmed to 25° C.

The pressure in the bulb was 30 mm to start. In one day at 25° C it became 40 mm and in 4 days 70 mm. The amount of B_2D_6 at the end of this time was 22 mm, and with it was 48 mm of a gas not condensable by liquid nitrogen. This was found to be greatly enriched HD.

HD of high concentration above equilibrium should be capable of being broken down to the equilibrium mixture, just as mixtures of H_2 and D_2 can be brought up to the equilibrium (*5*). This was done, and the results of heating with a nickel filament are shown in Fig. 1, where the mass spectra of various mixtures are shown for the main mass peaks 2, 3, and 4.

The mass spectra were obtained as follows. Maximum focus for each of the peaks from 1 (for H^+) to 6 (for D_2^+ molecular ion) was first ascertained. Then a magnetic scan was made, with 2000 volts accelerating, 70 volts ionizing. Calibrations were made with pure H_2, D_2, and known mixtures. A precise time schedule for gas admission and scanning was followed, identical for each analysis. This tended to cancel out or minimize any differential pumping effects (*7*). The scan was such that before each peak came up the adjustment for maximum focus could be made. The whole procedure yielded sensitivity relationships such as were found by Honig (*8*).

Fig. 1, Section A, shows the spectrum of a mixture of H_2 and D_2. The gas consisted of 45% H_2, 8% HD, and 47% D_2. On heating by a nickel filament at about 600° C, this equilibrated to give 30% H_2, 48% HD, and 22% D_2 (Fig. 1, Section B). The equilibrium constant found was $K = 3.5$.

The gas obtained by slow hydrolysis of B_2D_6 with H_2O, after the B_2D_6 and H_2O were condensed out by liquid nitrogen, gave the mass spectrum in Fig. 1, Section C. This gas was 85% HD, 8% H_2, and 7% D_2. After equilibrating by the hot filament this gas had the mass spectrum of Fig. 1, Section D, and the composition was 32% H_2, 48% HD, and 20% D_2, with $K = 3.6$. The values of K tabulated by Jones (*9*) give 3.87 at 627° C and 3.26 at 25° C.

That the reaction with water is the main event occurring is shown by mass spectra of B_2D_6 taken as the reaction proceeds. The 32/31 peak ratio went from 2.0 to 1.75, the rest of the spectrum remaining almost the same. This represents a relatively small amount of dedeuteration, since this ratio is very sensitive to departures from completely deuterated B_2D_6 composition. The fact that peak 32 does not represent adventitious oxygen is assured by the good resolution afforded by the spectrometer. This can resolve (*10*) the portions of peak 32 due to O_2 and due to $B_2{}^{11}D_5$ ion. No oxygen was found in this investigation.

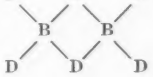
The chemical equations for steps in this method are:

$$B_2H_6 + 3D_2 = B_2D_6 + 3H_2 \qquad (1)$$

$$B_2D_6 + 3H_2O = B_2O_3 + 6HD. \qquad (2)$$

A naive picture for step (2) is to consider the terminal D atoms on the B as B(D)(D) and O(H)(H) the water molecule fitting into the $<$ in this manner: $<<$. This brings the O close to the B for reaction and the H and D in close contact to form HD. The concept seems less speculative if we recall (*1*) that in B_2H_6 the angle corresponding to B(D)(D) is 120°, and the angle in O(H)(H) is 105°. The interatomic distances, if B_2D_6 resembles B_2H_6, would be B – D = 1.18 A and O – H = 0.96 A. The dimensions are not inconsistent with this concept.

Extension of this simple picture leads to an explanation of why a maximum of 85% HD was attained. The bridge structure for diborane now seems well substantiated (*1, 6*). In the deuterated B_2D_6 the two central bonding D atoms are in an angular configuration different from the terminal D atoms, and in a plane at 90°:



If the four terminal deuteriums react as suggested, 4HD will be produced. If now the two central deuteriums are left to react with HOH *purely statistically*, there will be formed an additional $\frac{1}{4}(H_2 + 2HD + D_2)$. The final result is $5HD + \frac{1}{2}H_2 + \frac{1}{2}D_2 = 83.3\%$ HD + 8.35% H_2 + 8.35% D_2. These figures are nearly those observed. Paul Zemany of our laboratory suggested this last result.

The over-all reaction may be written $B_2H_6 + 3D_2 + 3H_2O = 3H_2\uparrow + B_2O_3\downarrow + 5HD + \frac{1}{2}H_2 + \frac{1}{2}D_2$ where the $3H_2$ is removed in step (1), the B_2D_6 being held by liquid N_2, and the B_2O_3 is removed in step (2) by deposition on the walls or in the acid, leaving behind a relatively pure HD.

The converse reaction of ordinary B_2H_6 with D_2O vapor at room temperature was also found to give HD

concentrations above equilibrium values, but the HD was less concentrated than that produced by the first method.

Wender, *et al.* (*13*) have prepared very pure HD by reacting D_2O with lithium aluminum hydride. Data for HD preparation by rectification of liquid H_2-HD-D_2 mixtures are given by Clusius and Starke (*3a*).

References

1. Bell, R. P. and Emeleus, H. J. *Quart. Rev.* (Chem. Soc., Lond.), 1948, 142.
2. Beutler, H., Brauer, G., and Junger, H. O. *Naturwiss.*, 1936, **24**, 347.
3. Dibeler, V. H. and Mohler, F. L. *J. Amer. chem. Soc.*, 1948, **70**, 987.
3a. Clusius, K. and Starke, K. *Z. Naturforsch.*, 1949, **4a**, 549.
4. Dibeler, V. H. *et al.* *Bur. Stand. J. Res.*, 1949, **43**, 97.
5. Farkas, A. and Farkas, L. *Proc. roy. Soc. Lond.*, 1934, **A144**, 16.
6. Hedberg, K. and Verner, V. Paper presented before 1949 meeting of American Chemical Society.
7. Honig, R. E. *J. appl. Phys.*, 1945, **16**, 646.
8. ———. *J. chem. Phys.*, 1948, **16**, 837.
9. Jones, W. M. *J. chem. Phys.*, 1949, **17**, 1062.
10. Norton, F. J. *Phys. Rev.*, 1949, **75**, 1957.
11. ———. *J. Amer. chem. Soc.*, 1949, **71**, 3488.
12. Rittenberg, D., Bleakney, W., and Urey, H. C. *J. chem. Phys.*, 1934, **2**, 48.
13. Wender, I., Freidel, R. A., and Orchin, M. *J. Amer. chem. Soc.*, 1949, **71**, 1140.

A Study of the Albumin and Globulin Content in Postpartum Plasma and Its Use in Rheumatoid Arthritis

Louis W. Granirer,

Arthritis Clinic, Queens General Hospital, Jamaica, New York

It was first reported from this clinic that a sustained remission can be produced in rheumatoid arthritis by the administration of suitable amounts of postpartum plasma (*1*). A review of the literature failed to reveal any data on the use of postpartum plasma in rheumatoid arthritis. The remission produced was characterized by an improved sense of well-being, a brighter mental outlook, increased appetite, a disappearance of joint symptoms, a gain in weight, restoration to normal of the microcytic anemia and albumin globulin ratio. In general, the characteristic response was a striking clinical improvement. There were no toxic effects, and in 320 postpartum plasma transfusions there were no cases of homologous serum hepatitis. The longest remission following cessation of therapy was 16 weeks and the shortest was 3 weeks. Postpartum plasma is an available and comparatively inexpensive form of therapy. During the investigation the author noted that the postpartum plasma had a greenish tint, slightly opalescent and homogeneously distributed.

TABLE 1

Postpartum Plasma Proteins (*4*)

Pool	Albumin mg %	Globulin mg %	Total protein mg%
1	2.1	2.8	4.9
2	2.1	2.2	4.3
3	2.7	1.8	4.5
4	2.4	2.3	4.7
5	2.0	2.1	4.1
6	2.1	2.6	4.7
7	2.1	2.0	4.1
8	2.5	1.6	4.1
9	1.7	2.4	4.1
10	1.9	2.1	4.0
11	2.2	2.3	4.5
12	2.0	2.2	4.2
Average	2.15	2.20	4.35

Table 1 reports the albumin and globulin content of the plasma obtained from 96 mothers after delivery. Each pool represents the pooled plasma of eight mothers.

Despite the hypoproteinemia, the mothers from whom this plasma was taken presented no anemia or edema. The typical average protein value was 4.35 mg % with an albumin globulin ratio of 0.9. The lack of correlation between plasma protein levels and edema was striking. A marked hypoalbuminemia was also observed and yet no impaired hepatic or renal function could be demonstrated. The postpartum plasma proteins reported here apparently resemble the pattern noted in the maternal sera at or near term (*5*). This similarity may provide an explanation for the efficacy of postpartum plasma in rheumatoid arthritis. The occurrence of pregnancy in patients with rheumatoid arthritis produces a partial or complete remission in a high percentage of cases (*2*).

At present there is no clear explanation of the ameliorating effect of postpartum plasma in the treatment of rheumatoid arthritis. There is suggestive evidence that this behavior is not due solely to a steroidal factor.

Further study of postpartum plasma will be reported.

References

1. Granirer, L. W. *7th int. Cong. rheumatic Dis.*, New York, June, 1949.
2. Hench, P. S. *Proc. Staff Meet.*, Mayo Clin., 1938, **13**, 161.
3. Moore, D. H., Martin, DuPan M., and Buxton, C. L. *Amer. J. Obstet. Gynec.*, 1949, **57**, 312.
4. Weichselbaum, T. B. *Amer. J. clin. Path.*, 1946, **10**, 40.

The Action of Pectinase Solutions on Sections of Acetone-fixed Human Tissues: A Preliminary Note

J. F. A. McManus and J. C. Saunders

Department of Pathology, The Medical College of Alabama, Birmingham

The action of enzymes on tissue sections is a source of chemical information. It has been found that solutions of diastase remove glycogen (*5*). The usefulness of the procedure is limited by impurity of the enzyme preparations and by complexity of the substrate (*2, 6*). This paper introduces commercial pectinase as an enzyme active on suitably fixed human tissues, and discusses the validity of the information derived from its use.

Thin pieces of human tissue are fixed in ice-cold ace-

tone, dehydrated and imbedded in paraffin by the method of Gomori (*3*). Sections of 4–6 μ thickness are baked on slides with glycerine egg albumin, then washed in toluene, graded alcohols, and finally in water. They are then incubated for 48 hr at 37° C in one of the following solutions, each at 0.4% strength: pectinase (Nutritional Biochemical Company or Rohm and Haas), pectinol O (Rohm and Haas), pectin esterase (Rohm and Haas), polygalacturonase (*4*), ß-glucuronidase (*1*).

The pH of the solution is adjusted to 4.0 by acetate-acetic acid buffer and checked with a Beckman pH meter. A crystal of thymol is added to each solution to inhibit bacterial growth.

After the period of incubation the slides are washed in running tap water for 5 min. The sections are stained with hematoxylin and eosin, or with the acid orcein stain for elastic tissue, or colored by the periodic acid-Schiff's reagent (PAS) method (*7*), with and without a counterstain of hematoxylin. Usually, each set of sections has been stained or colored by the three methods.

There is a loss of PAS-positive materials—mucin, glycogen, reticulin of spleen and lymph node, ground substance of cartilage, hyaline, etc.—with pectinase solutions. With pectinol O the removal is not so complete as with pectinase although qualitatively similar. Polygalacturonase removes about the same amount as pectinase. Pectin esterase does not remove PAS-positive material but enhances the coloration. ß-Glucuronidase does not remove PAS-positive material. Diastase in 1% solution at pH 6.8 removes everything, and usually the section from the slide with 48-hr incubation at 37° C. Pectinase solution does not remove nuclear material or elastic tissue.

Two effects of pectinase solutions are to be differentiated—one morphological and the other histochemical. The removal of hyaline, while leaving nuclear material and elastica, allows something like a microdissection on the slide. Elastic fibers of blood vessels become traceable in their finest ramifications. The hyaline in the glomeruli in Kimmelstiel-Wilson intercapillary glomerulosclerosis is seen to contain nuclear material. It can be completely removed, as can tubular basement membrane, whereas glomerular basement membrane is preserved.

The evidence that PAS-positive materials may be carbohydrates is enhanced by their removal by pectinase and especially by polygalacturonase. The data are not taken to be conclusive for the reasons mentioned earlier—complexity of enzyme and substrate. A pure enzyme is difficult to prove and a pure substrate is difficult to find, especially in nature. The chemical information should be considered conditional until pure enzymes, electrophoretically homogeneous and crystalline, have been used in a large series.

Techniques and results will be described in full in later publications. For the present, morphological information of definite value can be derived from the action of pectinase solutions on acetone-fixed human tissues. In the future, enzymes of the pectinase group may give chemical information about tissue structures composed of or containing the appropriate substrate.

References

1. Astwood, E. B. Unpublished observations, in Talbot, N. B., *et al., J. biol. Chem.*, 1943, **151**, 607.
2. Danielli, J. F. *Symposia of the society for experimental biology no. 1.* Cambridge: Cambridge Univ. Press, 1947. P. 101.
3. Gomori, G. *Proc. Soc. exp. Biol. Med*, 1945, **58**, 362.
4. Jansen, E. F. and MacDonnell, L. R. *Arch. Biochem.*, 1945, **8**, 97.
5. Lillie, R. D. and Greco, J. *Stain Technology*, 1947. **22**, 67.
6. Lison, L. *Histochemie animale: méthodes et problèmes.* Paris: Gauthier-Villars, 1936.
7. McManus, J. F. A. *Stain Technology*, 1948, **23**, 99.

The Action of Radioactive Phosphorus in Drosophila[1]

Johanna Blumel[2, 3]

Genetics Laboratory, The University of Texas, Austin

Since Muller's (*2*) classical discovery that x-rays produce mutations in *Drosophila melanogaster*, much attention has been directed to the study of this action. More recently ultraviolet light, radium, and chemicals have also been employed to induce mutations. Law (*1*) attempted to influence the lethal mutation rate of *Drosophila melanogaster* by the use of radioactive phosphorus. However, no lethals were found after injecting various concentrations of radioactive Na_2HPO_4 into 4-day-old larvae of the Oregon-R strain. In the present investigation, radioactive P^{32} was used to study the action of beta rays on *Drosophila melanogaster* and *Drosophila virilis*.

The stock of *Drosophila virilis* Sturtevant used is a lethal-free and fertile strain from Pasadena. The Muller-5 of *D. melanogaster* used has an X-chromosome marked by the dominant gene Bar (B), the recessive gene apricot (w^a), and the scute (sc^8) inversion.

In each case, pairs of mature flies from stock bottles were placed in shell vials containing a radioactive medium. This culture medium was prepared by adding approximately 3.2 ml of radioactive H_3PO_4 (containing about 1.54 mc/ml at the time of its use) to 300 ml of the standard *Drosophila* culture medium. The radioactivity of the original volume was determined with a Geiger counter, and was found to be 265,000 cpm/ml. The medium was distributed among 50 vials, each containing approximately 6 ml. Twenty-five vials were used to test *D. melanogaster*, and 25 for *D. virilis*.

Twelve days after exposure, the distribution of radioactivity in the various tissues of *D. virilis* and *D. melanogaster* was determined. The results are summarized in Table 1. The determinations on distributions of radioactivity on *D. virilis* were made on the original flies, the treated larvae, and the brains, gonads, and salivary glands dissected from treated larvae. No treated adult *D. virilis*

[1] This investigation was supported partially by a Rosalie B. Hite predoctoral fellowship.

[2] Present address, St. Joseph's Infirmary School of Nursing, Houston, Texas.

[3] I wish to thank Dr. G. S. Rabideau, Department of Botany, University of Texas, for his assistance and use of equipment.

TABLE 1

DISTRIBUTION OF RADIOACTIVITY IN TISSUES OF *Drosophila virilis* AND *Drosophila melanogaster*

D. virilis	No.	Net total count	Average count per tissue
Larval gonads	23	1374 cpm	59.7 cpm
Larval brains	30	3021 "	100.7 "
Larval salivary glands	30	7801 "	260.0 "
Entire larvae	5	11684 "	2336.8 "
Original ♂	5	13860 "	2772.0 "
Original ♀	5	18873 "	3776.6 "
D. melanogaster			
Entire larvae	5	5732 cpm	1146.4 cpm
Treated ♂	5	4335 "	867.0 "
Treated ♀	5	11044 "	2208.8 "

Net values corrected for background, but not for radioactive decay occurring when these samples were measured.

of the generation raised on the radioactive medium was tested for radioactivity, since only a small number hatched. On the other hand, the hatch of *D. melanogaster* was normal, and here the adults, as well as the larvae, of the generation reared on the radioactive medium, were checked for radioactivity.

All 25 vials of *D. virilis* were fertile and produced the average number of pupae. However, only 39 females and 25 males hatched. Without exception, these imagines were morphologically abnormal. This abnormality pertained mostly to the eyes, legs, abdomen, wings, and genitalia. Twenty-one females and 17 males survived to be tested for fertility to untreated flies. Of these only seven females were fertile.

The low hatch was obviously caused by lack of ability of the treated imagines to emerge. Dissections of unhatched pupae showed fully formed flies with similar or more extreme abnormalities than those just described.

The number of adult offspring from the seven treated *D. virilis* females was very low as shown in Table 2.

Table 2 also shows the number of flies that were again mated to untreated *D. virilis* males and virgin *D. virilis* females. The progeny from these pair matings was about normal in number for *D. virilis*, and enough flies from each tube were inbred so that the progeny from ten tubes could be examined for visible mutations.

The *D. melanogaster* flies were not tested for mutations. Of the treated flies tested for fertility, 78 out of 130 females and 56 out of 109 males were fertile in pair matings to nonirradiated flies. These produced the normal number of progeny.

Beta rays proved to be an excellent source of irradiation for *Drosophila virilis*. The mutations obtained from this treatment are as follows: an eye color, either apricot or an allele of apricot (sex-linked); a wing character, cut or cutlike (sex-linked); scute; extra scutellar bristles; a wing character with unusual venation; another wing character (sterile) in which the wings were folded and rotated 90°; extremely abnormal knobby eyes (both males and females also sterile). Several different mutations of the same general type produced flies with extended wings

TABLE 2

	1		2		3		4		5		6		7	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
No. adult offspring	15	24	2	5	1	3	2	3	4	4	3	2	6	4
No. mated	15	20	1	2	0	3	2	3	4	4	3	2	6	4

with added effects causing sterility. Among the progeny of yet another tube was a male with one apricotlike eye and the other eye a mosaic of areas respectively normal and apricotlike; when mated, no progeny was obtained.

Perhaps the most unusual and interesting mutation found was an aristapedialike character. The ten mutant flies examined (five males and five females) had leglike aristae, extended wings, crippled legs, and all bristles reduced to the size of hairs. They were nonviable and died soon after emergence. The mutant is retained by crossing the heterozygotes. Cytological examination of the salivary gland chromosomes of such heterozygotes show an inversion in the second chromosome. Whether or not this rearrangement is independent of the mutation has not yet been determined. The spineless-aristapedia locus in *D. melanogaster* is located in the right arm of chromosome 3, which is analogous to chromosome 2 in *D. virilis*. This coincidence of mutation and rearrangement in the same chromosome suggests that there is a connection between the mutation and the rearrangement.

The present investigation indicates that radioactive P^{32} not only produces mutations in *Drosophila virilis*, but also chromosomal rearrangements. The tolerance to such irradiation during development is high.

References

1. LAW, L. W. *Drosophila Information Service*, 1939, **11**, 46.
2. MULLER, H. J. *Science*, 1927, **66**, 84.

Chlorophyll Formation in Potato Tubers as Affected by Temperature and Time[1]

Ejnar C. Larsen

University of Idaho, Moscow[2]

In studies of chlorophyll formation, tubers of the potato (*Solanum tuberosum* L.) offer certain advantages as experimental material over the etiolated seedlings of different plants which have been employed commonly in the past for this purpose. The development of chlorophyll in the tubers seems to be dependent on temperature and time in the same general fashion as in etiolated seedlings. However, the rate of development of chlorophyll in potato tubers is slow, the tubers are not dependent on photosynthesis and can thus be kept alive for a long time at the low light intensities required for this kind of study, and by using potato tubers it is possible to avoid the complicating effect of growth of the tissue in which chlorophyll formation is occurring.

In the study here reported concerning the effects of temperature and time on chlorophyll formation, tubers of

[1] Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 299.

[2] Present address: Odense, Denmark.

the White Rose variety were used. Tubers approximately 2 in. in diam were selected for the experiment and inspected closely after washing to exclude tubers with even the slightest amount of greening. A single layer of

TABLE 1

CHLOROPHYLL CONTENT OF WHITE ROSE POTATO TUBERS EXPOSED TO 13–19 FOOT-CANDLES OF LIGHT AT DIFFERENT TEMPERATURES

Length of exposure, hr	Chlorophyll, mg/100 cm² exposed surface, at		
	40.9 ± 0.37 °F	51.4 ± 0.82 °F	66.3 ± 0.49 °F
72	0.02 ± 0.003	0.05 ± 0.002	0.16 ± 0.009
120	0.01 ± 0.005	0.09 ± 0.009	0.19 ± 0.022
240	0.02 ± 0.004	0.32 ± 0.014	0.33 ± 0.025
360	0.04 ± 0.005	0.48 ± 0.046	0.42 ± 0.011
480	0.10 ± 0.014	0.61 ± 0.010	0.41 ± 0.019
600	0.18 ± 0.011	0.71 ± 0.037	0.45 ± 0.010

tubers was arranged in circular fashion in three containers with mean temperatures of approximately 41°, 51°, and 66° F, respectively, with a 25-w Mazda lamp suspended 80 cm over the center of each lot. The light intensity at the level of the tubers was 19 foot-candles directly under the lamp and 13 ft-c at the periphery.

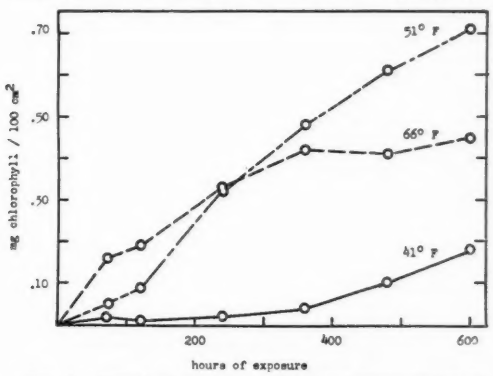


FIG. 1. Length of exposure to light, and concentration of chlorophyll in potato tubers maintained at three levels of temperature.

Samples, consisting of nine tubers each, and taken in a random manner were obtained from each temperature-controlled chamber after 72, 120, 240, 360, 480, and 600 hr of continuous exposure. Each tuber was sampled separately by cutting 10 disks, each 3 mm thick and 9.1 mm in diam, from the exposed surface. These disks were macerated and extracted in 95% ethanol for 24 hr and the chlorophyll concentration in the filtrate measured spectrophotometrically. The details of the procedure are described elsewhere (*1*).

The chlorophyll content in the tubers (Table 1, and Fig. 1) increased slowly at the low temperature 40.9° F throughout the experiment. At the medium temperature 51.4° F, the chlorophyll content increased relatively rapidly throughout the whole exposure period (600 hr) and the curve showed but little tendency to level off at the end of the experiment. At the high temperature of 66.3° F, the chlorophyll content increased most rapidly but reached a maximum after 360 hr of exposure and thereafter remained relatively constant throughout the rest of the experiment. For the first 120 hr the curves show the same general trend as those found by Lubimenko and Hubbenet (*2*) with wheat seedlings and by Smith (*3*) with barley seedlings.

These similarities give reason to believe that chlorophyll formation in potato tubers is dependent upon temperature and time in a manner which is, in principle, similar to the way the formation of chlorophyll in etiolated seedlings is dependent upon these factors. On this basis, the results have some significance in that they show that the temperature which promotes the most rapid development of chlorophyll, and thus can be termed optimum for this process, is not the temperature which promotes accumulation of the highest total amount of chlorophyll under prolonged exposure. Lubimenko and Hubbenet (*2*) found in their work that 79.8° F (26° C) was the optimum temperature for chlorophyll formation in etiolated wheat seedlings within the 72-hr limit of their experiment. They also assumed that the amount of chlorophyll accumulated at 79.8° F (26° C) after 72 hr of exposure was the total possible to accumulate at any temperature and length of exposure. However, by examining their results it can be seen that the curves obtained for 79.8° F (26° C) and 60.8° F (16° C) have trends which indicate that the two curves would have crossed if the experiment had been carried on long enough. Therefore, it occurs to the writer that Lubimenko and Hubbenet did not have sufficient reason to believe that the amount of chlorophyll accumulated at the end of their experiment at the optimum temperature 79.8° F was the absolute maximum possible to accumulate. Rather, their work indicates that they would have obtained results similar to those reported here had the exposure time been extended long enough.

It seems logical to assume that there is an absolute maximum for the amount of chlorophyll that can accumulate in the tissue of a certain species of plant. As far as the author is aware, the conditions of temperature, time, and genetic constitution which promote development of this maximum amount have not been established. However, the data for potato seem to suggest that this upper limit of chlorophyll accumulation will occur when the temperature is slightly above the lower temperature limit (approx. 38–39° F) at which chlorophyll formation takes place and after a very long period of exposure. The results obtained also lead the writer to believe that the nearer the temperature approaches a certain zero point for the process (possibly 38° F) the higher the maximum quantity of chlorophyll, provided the exposure period is extended accordingly. Further experiments are needed to prove or disprove this hypothesis.

References

1. LARSEN, E. C. *Idaho Agric. exp. Sta. res. Bull.*, in press.
2. LUBIMENKO, V. N. and HUBBENET, E. R. *New Phytol.*, 1932, **31**, 26.
3. SMITH, JAMES H. C. In Franck, James and Loomis, W. E., Eds. *Photosynthesis in plants*. Ames, Iowa: Iowa State College Press, 1949.

Comments and Communications

The Case Against The National Science Foundation

In the pages of *Science* during the last five years a number of articles have appeared in support of a National Science Foundation. There has recently come to the attention of the Executive Committee of the Inter-Society Committee a remarkable pamphlet published by the National Patent Council, a group which purports to represent "smaller manufacturers." This pamphlet seems to us to be a masterpiece of misinterpretation and intemperate vilification. We would like, therefore, to publish for the edification of those scientists who may not have had access to it, a summary of this extraordinary document with representative quotations and a bit of supplementary material designed to make its meaning clear but not to spoil its style.

According to this publication, the National Patent Council feels that the National Science Foundation envisaged by the pending bills would create "an independent Government agency empowered to invade all research and developmental activities of industry and individuals, and to confiscate and pool patents, for purposes of coercion and harassment of industry in perpetuation of political power." The pending bill contains language which "puts in the bill dictatorial fangs with which industry may be torn." In addition, the bill provides "for insidious invasions and penetrations of individual research and developmental operations of private industry—with effective mechanization for coercive acquisition of tangible and intangible property, including patent rights," and does this by "unbudgeted and unaudited bunghole financing." Not that all these dangers are obvious, they are concealed in "a bill so adroitly drafted as to have fully deceived not only the naive and nonlegalistic minds of some of our greatest and most patriotic citizens. For example, Vannevar Bush. . . ."

It appears from this pamphlet that a very substantial number of persons whom we had always considered to be outstanding citizens of the United States either have "naive and nonlegalistic minds" or are "Power Planners" or both. It also appears that most of these citizens are "self seeking proponents hoping to benefit from lavish appropriations made possible by the 'bunghole' type of Federal financing provided in the bill now pending." Many of them are representatives of institutions "out with a king-sized tin cup to get a heavy handout of Foundation funds" and many are "scientists identified repeatedly as members or affiliates of subversive organizations." In order that you may be fully aware of this situation, there is set forth below a partial list of the individuals concerned.

Harry S. Truman
Vannevar Bush
Robert P. Patterson
James V. Forrestal
Harold G. Bowen
R. L. Chappell
W. H. P. Blandy
W. R. Purnell
H. A. Schade
Louis De Flores
Lewis L. Strauss
Edward L. Bowles
William A. Borden
Horace M. Gray
J. R. Oppenheimer
H. J. Curtis
Robert Wilson
Harold L. Ickes
H. H. Arnold
Maury Maverick
Bruce K. Brown
J. Hugh O'Donnell
A. N. Richards
Francis G. Blake
John P. Peters
Cornelius P. Rhoads
Allan Butler
Robert P. Fischelis
Ewan M. MacEwan
Morris Fishbein
Homer W. Smith
Ross T. McIntire
R. E. Dyer
Norman T. Kirk
David D. Rutstein
Henry B. Richardson
Lawrence S. Kubie
L. C. Dunn
D. W. Bronk
Edmond W. Sinnott
L. J. Stadler
W. M. Stanley
H. B. Steinbach
Selman A. Waksman
Raymond Zirkle
Robert F. Griggs
Philip R. White
Karl T. Compton
Henry DeW. Smyth
Harold C. Urey
Abel Wolman
Howland H. Sargeant
Casper W. Ooms
C. E. MacQuigg
Thorndike Saville
Boris A. Bakhmeteff
A. G. Christie
F. Malcolm Farmer
J. H. Rushton
Robert H. Morris
Frank D. Kern
Luther H. Evans
P. V. Cardon
Isaiah Bowman
Irving Langmuir
Harlow Shapley
Henry A. Wallace
F. R. Moulton
Howard A. Meyerhoff
Harold D. Smith
J. C. Hunsaker
Lewis G. Hines
Russell Smith
Watson Davis
R. J. Dearborn
Orville Freeman
Harry Malisoff
Wesley C. Mitchell
John M. Gaus
Robert M. Yerkes
E. G. Nourse
William F. Ogburn
John M. Cooper
Edmund E. Day
Watson B. Miller
Paul A. Porter
Bradley Dewey
Roger Adams
L. A. DuBridge
Lewis Alan Berne
Edwin H. Land
Robert K. Lamb
Leonard Carmichael
Walter Rautenstrauch
John Magruder
J. S. Denslow
Emanuel Celler
William A. Higinbotham
Thomas Parran
Carroll Wilson
William C. Foster
Randolph T. Major
P. F. Lee
R. G. Gustavson
Ralph McDonald
Douglas E. Scates
Thomas A. Jenkins
Wilbur D. Mills
W. John Kenney
John F. Victory
George E. Folk
E. U. Condon
James B. Conant
I. I. Rabi
Morris L. Cooke
Harry Grundfest
Kirtley Mather
L. D. Leet

John Studebaker
Lewis H. Weed
Fred J. Kelly
R. E. Gillmor
George Zook
Ewing Cockrell
Bernard M. Baruch
Henry Allen Moe
John Milton Potter
Ralph W. Tyler
Mortimer Graves
William Charles White
Clifford Grobstein
Lawrence R. Hafstad
H. P. Hammond
J. A. Reyniers
Charles Sawyer
Hugh Wolfe
John T. Cox, Jr.
P. J. Federico
Harry P. Hammond
Myron Francis Hill
Lawrence C. Kingsland
John H. Teeter
M. H. Trytten
James E. Van Zandt
Charles E. Waring
Frank MacIntosh
C. F. Kettering

All of the persons named appeared and testified before various Congressional committees in support of National Science Foundation legislation. There was considerable testimony of like character submitted in writing by persons described by the National Patent Council as "so-called scientists committed to subversive ideologies, and often affiliated with Communistic organizations . . . believed not to have dared to appear in person and submit to questioning by members of the committee as to their subversive affiliations." A partial list of these persons is set forth below and again we should state that these persons have enjoyed rather high reputations.

W. C. Coffey
R. M. Tuttle
R. Morton Adams
James E. Jagger
Luther H. Evans
Oscar L. Chapman
R. R. Renne
O. H. Steiner
Ancel Keys
A. Sidney Harris
Chauncey D. Leake
Lawrason Riggs
Irving Michelson
R. B. Marston
Louis Knott Koontz
Donald Armstrong
I. M. Kolthoff
Albert S. Goss
James E. Webb
N. E. Dodd
John W. Snyder
David E. Lilienthal
Charles E. Bohlen (for Secretary of State)
Mrs. Jack Fahy
C. G. Suits
Frank W. Hubbard (for American Educational Research Association)
F. M. Dawson
Richard M. Noyes
Harlan T. Stetson
Robert C. Clothier
W. T. Sanger
Carl M. Anderson (for Merck & Co., Inc.)
Virgil M. Hancher (for National Association of States Universities)
Stewart E. Hazlet
Ruth M. Leverton
Dean Acheson
Robert G. Sproul
F. G. Brickwedde (for Washington Academy of Sciences)
P. G. Worcester
Linus Pauling
Sid Robinson
Alfred C. Nelson
Robert E. Lutz
R. K. Summerbell
Laurence B. Heilprin
S. M. Cantor (for Chicago Chemists' Club)
D. R. Hoagland
Hardy L. Shirley
George S. Avery, Jr.
William Voight, Jr. (for Izaak Walton League of America)
Frederick George Smith
Robert Chambers (for Union of American Biological Societies)
B. H. Willier (for American Society of Zoologists)
Theodore G. Klumpp (for American Pharmaceutical Manufacturers Association)
James L. Orr (for TIES Association of Miami)
H. B. Wilcox (for New York Academy of Medicine)
Stanley Dorst (for Medical Research Workers at the University of Cincinnati)
Torald Sollimann (for American Medical Association)
C. E. Earle
H. H. Dukes
Thomas Francis
Henry S. Simms
Frank C. Mann
Ward Darley (for University of Colorado, School of Medicine Faculty)
James B. Hickman
Herbert F. Lowe
Phillip N. Powers
George B. Cressey
E. C. Koerper
D. L. Blackstone, Jr.
Clarence M. Fisher (for American Patent Law Association)
Albert F. Blakeslee
Harry Sobotka
Richard Courant

Now it appears from this pamphlet that among other things a National Science Foundation is quite unnecessary, for the National Academy of Sciences is adequate to perform all of the functions for the accomplishment of which the Foundation is proposed. You will be interested to know that the National Academy of Sciences is nonpolitical and that it includes "more than three hundred of the top scientists of the country, with rare and now-identified exceptions, men of unquestioned loyalty." These "exceptions" are not named but are presumably the many members of the National Academy who have supported the National Science Foundation.

In discussing the merits of the issue, the pamphlet utilizes a variation of the Socratic method of exposition. It makes an assertion as to what is claimed by "proponents of this bill" followed by a statement labeled "The Contrary Truth." We think that all three arguments presented in this manner should be presented to you.

1. "Proponents claim the Foundation will integrate and coordinate the numerous research activities now being conducted by more than thirty governmental agencies and departments.

"*The Contrary Truth*: The bill . . . provides . . . for insidious invasions and penetrations of individual research and developmental operations of private industry—with effective mechanization for coercive acquisition of tangible and intangible property, including patent rights. . . .

2. "Proponents of the Science Foundation bill say there is need in this country for basic research for which we have heretofore relied upon Europe.

"*The Contrary Truth*: . . . the Foundation is implemented for invasions of the field of applied research in every phase of science.

3. "Proponents of the bill say that it is needed to set up a register of scientific personnel available in the United States.

"*The Contrary Truth*: This register has been compiled comprehensively long since by the National Academy of Sciences. . . ."

The pamphlet closes with a long list of the types of people who are for the bill and the types who are opposed

to it. We have already named most of the individuals who have testified or submitted statements in favor of the bill and described some of their characteristics as seen by the National Patent Council. In addition, according to this Council, some or all of them are also "predatory politicians," "members of Government bureaus, commissions and agencies seeking constantly to increase the scope of governmental controls of industry and of the lives of all citizens," "'rubber stamps,' misguided members of Congress" and "people who are greatly impressed by preambles and grandiose statements of purpose but have not the disposition, and perhaps not the ability, to anticipate the legal and economic consequences of the legislation." We are not sure into which of these categories the National Patent Council fits Senators Thomas (Utah), Kilgore, Fulbright, Magnuson, Smith (New Jersey), Cordon, and Saltonstall, who sponsored the Senate bill (S. 247), or Representatives Priest, Mills, Van Zandt, Wolverton, Harris, and Celler, who introduced bills in the House.

The Council states that the bill is opposed by (1) "a vast majority of the many thousands of usually inarticulate smaller manufacturers. . . ." (2) "[the late] Dr. Frank B. Jewett. . . ." (3) "Various outstanding scientists more closely identified with the scientific realities of industry. . . ." (4) "members of Congress fearful of the power of the proposed Science Foundation to invade social, economic and political realms heretofore regarded as necessary to reserve to the citizen in perpetuation of the principles of incentive economy under constitutional government. . . ." (5) "Congressmen fearful of any centralized organization empowered . . . 'to foster the interchange of scientific information among scientists in the United States and foreign countries.' . . ." (6) ". . . members of the House who understand that the establishment of such a Foundation would substantially destroy the high utility of the National Academy of Sciences—and may in fact have that destruction as one of its purposes. . . ." (7) ". . . members of the House who feel they have reason to fear that the establishment of the Foundation would result in a systematic breaking down . . . of public resistance to a disastrous repetition in America of the British capitulation . . . to such demoralizing and economically degenerating indulgences in political bribery and loot as is present in socialized medicine, socialized industry and other symptoms of economic cannibalism and social disintegration in such painful evidence in Britain." (8) "Congressmen who fear that . . . the Foundation could be made perhaps a decisive influence towards submission of voters to political bribery in the form of tax-supported handouts made in the name of social justice." (9) ". . . members of Congress who have become weary and frightened because of mounting pressures for bunghole type financing. . . ." (10) "Congressmen who . . . understand that organizations and individuals seeking new handouts by Government have no fury like that of those seeking to retain, and increase the rate of, handouts once begun. . . ." (11) "Congressmen who fear that to place in the hands of one man, called Director of the Foundation, such power (Sec. 5, H. R. 4846) as could make committees and other agencies of the Foundation largely advisory window dressing, is not in the public interest." (12) ". . . members of Congress who fear that provisions for the pooling of patents by the foundation (Sec. 12, H. R. 4846) soon would enable the Foundation to build patent pools capable of bludgeoning American Industry into acquiescence in arbitrary and confiscatory activities of the Foundation. . . ."

We were electrified by the interpretation placed on H. R. 4846 and its predecessors by the National Patent Council and we cannot help but wonder whether the proprietor of the National Patent Council has read any of those bills through. In any event, we suggest that anyone interested might do well to read H. R. 4846 in the light of the National Patent Council pamphlet and communicate his opinion to his Congressman.

EXECUTIVE COMMITTEE
INTER-SOCIETY COMMITTEE

Washington, D. C.

Nucleotide Content of Bacteriophage Genetic Units

Inactivation and recombination experiments (Luria, S. E. and Dulbecco, R. *Genetics*, 1949, **34**, 93) with T2 bacteriophage indicate that there are approximately 25 essential genetic units analogous to genes in this virus. These are generally assumed to be nucleoprotein in nature, although it has been pointed out (Zahler, S. A. Essay submitted to the Department of Bacteriology and Parasitology, University of Chicago, 1949) that at least some of them may consist of nucleic acid only, without associated proteins. Since the bulk of the evidence indicates that almost all of the phosphorus in the bacteriophage is contained in the nucleic acid, we may readily calculate the number of nucleotides in the genetic units.

Various analyses of T2 have shown that approximately 4.5% of the 2.5×10^{-16} g mass of the bacteriophage is phosphorus. This is equivalent to some 200,000 phosphorus atoms, and, therefore, about this number of nucleotides is present. If we accept 25 as the number of genes, then some of the genes, at least, contain not more than 8,000 nucleotides. This corresponds to a molecular weight, for the nucleic acid portion of the genes, of less than three million.

STANLEY A. ZAHLER

1547 35th Avenue North
St. Petersburg, Florida

NEWS and Notes

Alfred Whitney Griswold, professor of history at Yale University, and faculty member since 1933, has been elected to succeed **Charles Seymour** as Yale's 16th president. Dr. Seymour, also a professor of history when he was elected president 13 years ago, leaves the university on June 30 at the retirement age of 65.

Walter H. Laves will leave his position as deputy director-general of Unesco at the end of June. Dr. Laves has been active since 1946 in the development and coordination of Unesco's program, and was concerned with organizing the staff to carry it out, as well as setting up general administration and financial procedures. In his letter of resignation, Dr. Laves said that after three years in Paris he felt obliged for family and professional reasons to return to the U. S.

Philip J. Elving, professor of analytical chemistry at Pennsylvania State College, **Wayne A. Kirklin,** manager of the analytical division of the Hercules Experiment Station, and **Edward Wichers,** chief, Chemical Division of the National Bureau of Standards, have been appointed to the advisory board of *Analytical Chemistry,* publication of the American Chemical Society.

John C. Brauer, dean of the School of Dentistry, University of Southern California, has been appointed dean of the new School of Dentistry, University of North Carolina, effective March 1.

Donald B. Armstrong, vice president of the Metropolitan Life Insurance Company and of the National Safety Council, has been named chairman of the committee on medical information by the New York Academy of Medicine. Dr. Armstrong has been a member of the committee since 1938.

Isaac Berenblum, formerly at the Sir William Dunn School of Pathology, University of Oxford, England, and at present a special research fellow at the National Cancer Institute, Bethesda, Maryland, has been appointed head of the department of experimental biology at the Weizmann Institute of Science, Rehovoth, Israel. Dr. Berenblum will take up his new duties in Israel in September.

Ion Carstoiu, of the University of Paris, has been appointed assistant professor, and **A. C. Smith,** formerly of Stonehurst College, Lancashire, England, has received an instructorship at Johns Hopkins University in the department of mathematics.

Norman D. Humphrey, associate professor of sociology, Wayne University, will serve for a year at Escuela Superior, Bogota, Colombia, as visiting professor of social anthropology. During this time he will also conduct research on an agricultural village. **John Biesanz** of Tulane University, a specialist in contemporary Latin American sociology, will take Dr. Humphrey's place during his absence.

Cyrus C. Erickson, specialist in surgical pathology, has resigned from the faculty of Duke University to become professor of pathology at the University of Tennessee.

Sumner T. Pike assumed the acting chairmanship of the Atomic Energy Commission on February 15 following the resignation of **David E. Lilienthal.** Mr. Pike, who early in 1947 was formally designated to serve as acting chairman whenever Mr. Lilienthal was not present, will fill the post on a temporary basis for several weeks or months until a permanent replacement is appointed by President Truman.

Visitors to U. S.

Nils Svartholm, professor of the Nobel Institute in Stockholm, has arrived at Indiana University, Bloomington, where he will be visiting professor of physics for the spring semester.

P. Ferriera-Berrutti, University of Montevideo, **Gert Andres,** University of Bern, and **Fiametta Rossetti,** University of Rome, are conducting experiments at the University of Chicago on the development of the nervous system. They are working under the supervision of Paul A. Weiss, professor of zoology. Dr. Ferriera-Berrutti, a professor of histology and embryology, is studying experimental techniques on factors controlling connections between the eye and brain. Dr. Andres' work, jointly financed by a Swiss foundation and the American Cancer Society, involves differentiation in embryos. Miss Rossetti is continuing work begun in Italy on the early stages of development of different parts of the brain. All three scientists are working under grants from researeh foundations and fellowships from the University of Chicago.

D. J. Bell, professor of chemistry, School of Biochemistry, Cambridge University, England; **L. J. Oosterhoff,** Shell Laboratories, Amsterdam, Netherlands; **M. de Hemptinne,** University of Louvain, Belgium; **R. A. Ledrus,** Ecole Royale Militaire, Brussels; and **H. Robiliart,** president of Union Miniere du Haut Katanga, Brussels, were recent visitors at the National Bureau of Standards.

Grants and Awards

The Elizabeth Blackwell Citations for 1950 were awarded on January 29 to five American women physicians for their contributions to the practice and teaching of medicine. Those receiving awards were: *Ruth Morris Bakwin,* assistant clinical professor of pediatrics at New York University and director of the pediatric service at New York Infirmary, for her work in pediatrics; *Leona Baumgartner,* associate chief, U. S. Children's Bureau, and assistant commissioner of the New York City Health Department, for her improvement of public health services for children; *Elise S. L'Esperance,* pathologist and director of laboratories at the New York Infirmary, and assistant professor of preventive medicine (cancer) at the

Cornell University Medical College, for her achievements in pathology and cancer detection; *Elaine R. Ralli*, associate professor of medicine and chief of the Metabolic Clinic at New York University-Bellevue Medical Center, for her work in the study of metabolic and nutritional diseases; *Barbara B. Stimson*, orthopedist and director of services at the St. Francis and Vassar Brothers Hospitals, Poughkeepsie, for her work in orthopedic surgery.

The Blackwell awards were established last year to commemorate the 100th anniversary of the graduation of Elizabeth Blackwell, the first woman to receive a medical degree in America.

Lyndon Frederick Small, head chemist of the National Institutes of Health, Bethesda, Maryland, will receive the 1950 **Hillebrand Prize** of the Washington Section of the American Chemical Society at a dinner meeting March 9. Dr. Small was cited for his outstanding contribution to the chemistry of alkaloids. The Hillebrand Award was established in 1925 in honor of William Francis Hillebrand, chief chemist of the National Bureau of Standards from 1908 to 1925. The award is made each year to a member of the Washington Section who has made a notable contribution to chemistry during the three preceding years.

The Francis P. Garvan Medal of the American Chemical Society will be given this year to Pauline Beery Mack, director of the Ellen H. Richards Institute, and professor of household chemistry at Pennsylvania State College. Dr. Mack is cited for her work on the calcium chemistry of bone density. The award will be made at the society's annual meeting in Detroit on April 17.

The Massachusetts Institute of Technology has been granted one million dollars by the Campbell Soup Company. The grant will support the institute's research program in the fields of biology and food technology and in related scientific and engineering subjects. Construction of a new building to house the Departments of Biology and Food Technology is planned. It will be named in memory of John Thompson Dorrance, who was president of the Campbell Soup Company for 16 years until his death in 1930.

Fellowships

The Atomic Energy Commission will sponsor a fellowship program during the 1950–51 academic year in which it is expected that 139 fellowships will be offered in the physical sciences and 105 in the biological sciences. This program will be in addition to the 250 fellowships administered by the National Research Council. Subjects of research in the new program must be so related to atomic energy that the candidate will be especially suited for employment by the AEC or its contractors—a requirement not made in previous programs. The program will be administered in the Northeast by Associated Universities, Inc., and in the Southeast by the Oak Ridge Institute of Nuclear Studies, Inc. Selection of fellows in the Midwest will be made by the Midwest AEC Fellowship Board, established by the Board of Governors of the Argonne National Laboratory, and in the West by the Western AEC Fellowship Board, at the University of California in Berkeley. Applications must be filed by *March 4* in the area office of the region where study is desired.

The Arthur D. Little Fellowship for a graduate student studying for the M.A. degree in mathematics, physics, chemistry, or a biological science will be awarded for 1950–51 at Smith College. The fellowship has a value of $1,200, which covers tuition and residence fees.

Additional teaching fellowships in botany and genetics, chemistry, geology, hygiene and bacteriology, physics, and zoology (two or more in each department) are also available and will pay $900 for the first year and $1,000 for the second year, with remission of tuition fees. Several research fellowships, seven trustee fellowships of board, room, and tuition, and four tuition scholarships are also offered to students in science. Application blanks and further information may be obtained from Miss Florence E. Young, Graduate Office, Smith College, Northampton, Massachusetts. All applications must be received not later than *March 1*.

Colleges and Universities

Western Reserve University will hold its ninth annual series of "Frontiers in Chemistry" lectures March 3–March 31 and April 14–May 12 in the Adelbert Main Building, university campus, Cleveland. Dates and speakers for the first group of lectures on "The Metallic State" are: March 3—*K. S. Pitzer*, professor of chemistry, University of California; March 10—*R. A. Ogg, Jr.*, professor of chemistry, Stanford University, now visiting lecturer at Harvard; March 17—*G. L. Clark*, professor of chemistry, University of Illinois; March 24—*H. H. Uhlig*, associate professor of chemistry, Massachusetts Institute of Technology; March 31—*John H. Hollomon*, assistant head, Metallurgy Division, General Electric Company.

Dates and speakers for Part II, "New Techniques in Organic Chemistry," are April 14—*Louis F. Fieser*, professor of organic chemistry, Harvard University; April 21—*C. W. Gould*, Central Research Laboratory, General Aniline and Film Corporation; April 28—*Stanford Moore*, associate member, Rockefeller Institute for Medical Research; May 5—*W. E. Hanford*, vice president, M. W. Kellogg Company; May 12—*Thomas L. Gresham*, director, Organic Chemicals Research, B. F. Goodrich Company.

The University of Wisconsin will offer a specialized course in science writing for undergraduates next year. This is an outgrowth of an attempt begun in 1947 by Scott M. Cutlip, Wisconsin professor of journalism, to find a way to reconcile the scientist's demand for accurate writing with the layman's need for understandable scientific language. He had the enthusiastic backing of Conrad A. Elvehjem, dean of the Graduate School (and co-originator of *Nutrition Reviews*) in establishing a graduate science writing fellowship

for the academic year 1948–49. The pioneer work done by the first two fellows, Kenneth G. Johnson (who is now teaching journalism at Michigan State College) and Jane Davidson (current holder of the fellowship) has led to the new course, which the university hopes will be suited to both scientists and writers, and will help to close the gap between them.

Lecturers who will visit the **University of Tennessee** as guests of the Department of Philosophy and Psychology during the spring quarter are *Urie Bronfenbrenner*, Cornell University, to discuss psychological theory of group behavior; *Jerry W. Carter, Jr.*, National Institute of Mental Health, public health services; *Clyde Kluckhohn*, Harvard University, social anthropology; *Karl S. Lashley*, Orange Park, Florida, clinical neurology; *Ronald Lippitt*, University of Michigan, group dynamics; and *O. Hobart Mowrer*, University of Illinois, psychotherapy. The lecture series is made possible by funds allocated to the university by the U. S. Public Health Service.

A graduate program offering a master of science degree in the teaching of chemistry has been inaugurated at **St. Louis University.** The program provides scientific training for secondary school chemistry teachers. Students must hold a B.S. degree in chemistry or its equivalent, or must complete an equal amount of work as part of the graduate program. George W. Schaeffer, director of the Chemistry Department, will head the program. A summer institute in teaching chemistry will be included in the course.

A university laboratory of physical chemistry related to medicine and public health has been established by **Harvard University.** The program of the new laboratory, under the direction of Edwin J. Cohn, university professor, will be aimed at fundamental studies of the constituents of body fluids and tissues and extending research on the physical chemistry of proteins. Dr. Cohn's staff includes John T. Edsall, and John L. Oncley, associate professors, W. L. Hughes, Jr., assistant professor, five research associates, and ten postdoctoral fellows, as well as graduate students and technicians.

Summer Programs

A statistical summer session will again be held at the University of California, Berkeley, with courses offered on both graduate and undergraduate levels. The graduate courses are designed primarily for students holding the Ph.D. degree or working toward it, and there will be no specific prerequisites. William G. Cochran, Johns Hopkins University, Benjamin Epstein, of Wayne University, Erich L. Lehmann, University of California, Paul Levy of the Ecole Polytechnique, Paris, and Gottfried E. Noether, New York University, will be included in the faculty.

The Massachusetts Institute of Technology will offer six special courses in its 1950 summer session. The three-week food technology course was announced in *Science*, February 10, p. 158. The other courses will be in climatology, colloid chemistry, mathematics, instrumental analysis, and infrared spectroscopy, designed primarily for industrial, technological, and scientific people. Further information can be obtained from Prof. Walter H. Gale, Director of the Summer Session, Room 3-107, MIT, Cambridge 39, Massachusetts.

Oklahoma Agricultural and Mechanical College will hold its first annual summer session for advanced courses and research in biological sciences at its wildlife conservation station near Greenleaf Lake, in east central Oklahoma, June 10–August 5. Further information may be had by writing to W. H. Irwin, Department of Zoology, Oklahoma A. & M. College, Stillwater, Oklahoma.

Industrial Laboratories

John Remensnyder has been elected president of the **Heyden Chemical Corporation,** to succeed the late Bernard R. Amour. Mr. Remensnyder has been with the company since 1920, and was elected a director and vice president in charge of sales in 1944.

Sterling L. Redman, head of the **Redman Scientific Company** of San Francisco and Los Angeles for the past 15 years, has sold his stock in that company to the **Central Scientific Company.** He has established offices in San Francisco and Pasadena for the sale of specialized equipment and instruments for laboratories, pilot plants, and process industries.

Max Gilbert, formerly medical director of the Wm. R. Warner Company and the Bilhuber-Knoll Corporation, has joined the **Ames Company, Inc.,** Elkhart, Indiana, as medical director.

Deaths

Julius Lips, 55, ethnologist and rector of Leipzig University, has died in Leipzig after a brief illness. Dr. Lips resigned his post as head curator of the anthropological museum of Cologne University when the Nazis came into power, and became visiting professor of anthropology at Columbia University. Later he was professor of anthropology at Howard University, Washington, D. C. Of his numerous writings, *The Savage Hits Back* and *The Origin of Things* were published in the U. S.

M. Maxim Steinbach, specialist in pulmonary diseases and research associate in bacteriology at the College of Physicians and Surgeons, Columbia University, where he had been associated for more than 25 years, died February 1, at the age of 57. Dr. Steinbach's chief interest was in tuberculosis.

Frank Gouldsmith Speck, 68, authority on the American Indian, and professor of anthropology at the University of Pennsylvania where he had taught since 1911, died February 6. Dr. Speck's studies were principally on Indian tribes of the Eastern seaboard. He was the author of 200 books, monographs, and other publications on anthropological subjects.

Hyym Elias Buc, organic chemist, died at his home in Roselle, New Jersey, January 21, at the age of 69. When he retired in 1943, Dr. Buc had served for 24 years with the Standard Oil Development Company and at

the time of his death he held 130 patents in the petroleum field. As an expert in analyzing the opiate content of foods, he played a part in development of pure food laws.

Herbert Eustis Winlock, archaeologist and director emeritus of the Metropolitan Museum of Art, died January 26, in Venice, Florida, at 65. Dr. Winlock began his excavations for the museum in 1906, was director of expeditions to Egypt from 1928 to 1932, and curator of Egyptology from 1929 to 1939, when he retired from active work.

John A. Kenney, Negro medical leader, died January 29 of cerebral thrombosis at the age of 75. In 1912 Dr. Kenney instituted the John A. Andrews annual clinics at Tuskegee Institute, and in 1927 he founded in Newark the institution now known as Community Hospital.

The Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, announces the publication of two new quarterly journals, *Australian Journal of Agricultural Research,* and *Australian Journal of Applied Science.* It is expected that four issues of each will appear this year. Subscriptions may be obtained from the secretary of the organization, 314 Albert Street, East Melbourne, C.2. Australia, at the rate of 30 shillings per annum for each journal.

A new society, the **American Crystallographic Association,** was formed January 1, to incorporate and carry on the activities of the American Society for X-Ray and Electron Diffraction and the Crystallographic Society of America, whose activities were officially ended on that date. It had become evident at the end of the war that these two groups had in common many interests, and as the societies grew their differences became less, and there developed many overlapping activities. The fact that programs of recent meetings have been indistinguishable in content probably had much influence in bringing about the combination, which had been suggested since 1945.

The councils of both societies organized a joint committee in 1948 to make plans for combining their activities, assisted by the Committee on Crystallography of the National Research Council. The proposal drawn up by this joint committee was discussed at business meetings of each of the groups, and the final step was taken August, 1949, when the mail ballot taken from both memberships returned a vote favorable to the formation of a new society. According to the aims stated in its constitution, "The object of this Society shall be to promote the study of the arrangement of atoms in matter, its causes, its nature and its consequences, and of the tools and methods used in such studies."

An election ballot returned by the ACA charter members, now numbering 496, determined the following officers for the first year: president, I. Fankuchen, Polytechnic Institute of Brooklyn; vice president, R. W. G. Wyckoff, National Institutes of Health; secretary, H. T. Evans, Jr., Philips Laboratories, Inc.; treasurer, J. Karle, Naval Research Laboratories.

Meetings of the new society will be held twice yearly, and the first is scheduled for April 10–12 at Pennsylvania State College. Further information concerning the society may be obtained from the secretary, Dr. Howard T. Evans, Jr., Philips Laboratories, Inc., Irvington-on-Hudson, New York.

The Chicago Natural History Museum has received from Philip Hershkovitz, assistant curator of mammals, a collection of 755 mammalian specimens from the states of Bolivar and Magdalena, in Colombia. Dr. Hershkovitz, leader of the Colombian Zoological Expedition, has made collections from seven localities in northern Colombia, and these specimens represent practically all the known species of the region and some not previously recorded from that country.

Admiral William H. P. Blandy, who recently retired from the Navy will be president of the **Health Information Foundation,** a newly organized private organization. The foundation, supported by drug, pharmaceutical, and allied firms, will develop and disseminate information on health problems. In accepting his appointment, Admiral Blandy said that one of the foundation's first projects will be to examine "the facts about health facilities in relation to population, and its distribution."

The Scientific Research Society of America announces the granting of charters in recent weeks to member groups at: U. S. Public Health Service, Communicable Disease Center, Atlanta; Hoffman-LaRoche Company, Nutley, New Jersey; Chemical Corps Laboratory, U. S. Army, Camp Detrick, Frederick, Maryland; U. S. Bureau of Mines, Albany, Oregon; Ordnance Laboratory, U. S. Army, Frankford Arsenal, Philadelphia. Donald B. Prentice, Yale University, is director of the new organization, which is sponsored by the Society of Sigma Xi.

Make Plans for—

American Institute of Chemical Engineers, regional meeting, February 26–March 1, Rice Hotel, Houston, Texas.

Institute of Radio Engineers, annual convention, March 6–9, Hotel Commodore and Grand Central Palace, New York City.

Symposium on "La Structure et la Physiologie des Societes Animales," March 19–25, Paris, France.

The Special Libraries Association, March 22–24, Statler Hotel, Washington, D. C.

Michigan Academy of Science, Arts, and Letters, 54th annual meeting, March 23–25, University of Michigan.

National Meeting on Histochemistry, March 25, Department of Anatomy, University of Pennsylvania, Philadelphia.

National Society for the Prevention of Blindness, March 26–30, Floridian Hotel, Miami Beach, Florida.

American Association of Dental Schools, March 27–29, French Lick Springs Hotel, French Lick, Indiana.

American Chemical Society, 177th national meeting, opening session March 26–30, Houston, Texas.

Personnel Placement

CHARGES and REQUIREMENTS for "PERSONNEL PLACEMENT" Ads

1. Rate: 15¢ per word, minimum charge $3.00 for each insertion. If desired, a "Box Number" will be supplied, so that replies can be directed to SCIENCE for immediate forwarding. Such service counts as 8 words (e.g., a 25-word ad, plus a "Box Number", equals 33 words). All ads will be set in regular, uniform style, without display; the first word, only, in bold face type.

For *display* ads, using type larger or of a different style than the uniform settings, enclosed with separate border rules, the rate is $16.00 per inch; no extra charge for "Box Numbers".

2. Advance Payment: All Personnel Placement ads, *classified* or *display*, must be accompanied by correct remittance, made payable to SCIENCE. Insertion can not be made until payment is received.

3. Closing Date: Advertisements must be received by SCIENCE, 1515 Mass. Ave., N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

POSITIONS WANTED

Academic Position with research opportunity is desired by Ph.D., age 29, with broad training including four years of industrial research experience and one year post-doctoral fellowship. Organic chemistry, pharmaceuticals, natural products (sterols). Box 42, SCIENCE. X

Bacteriologist: Sc.D.; two years, bacteriologist and chemist, large food manufacturing company; eight years' teaching experience, four years as professor and head of department, state university; several years, director, and charge control department of penicillin, biological manufacturing company; for further information, please write Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

Biometrician: Ph.D. (Applied Statistics), M.Sc. (Zoology); 12 years experience consultation and research; wants academic appointment in biological or agronomic work. Box 46, SCIENCE. X

M.S. in Zoology: Age 29, with one year college teaching experience, desires position in midwestern college. Box 45, SCIENCE. X

Physiologist: Instructor at eastern medical school. Desires teaching or research assistantship with option of taking courses for the M.D. degree. Research on brain metabolism and on tuberculosis. Box 47, SCIENCE. X

Plant Physiologist: Ph.D., microorganism and higher plant research, teaching, and administrative experience. Desires academic location. Box 43, SCIENCE. X

Scientific Librarian: Graduates in Zoology and Bacteriology, B.Ls. from an accredited Library School plus two years library experience. Desire a position in a small scientific library, preferably in Ontario or British Columbia, by September or October. Box 37, SCIENCE. 2/24

Technician: Female. B.S. Four years valuable experience in biochemistry, enzymes, cancer research. Publications. Desires research assistantship in hospital or university. Box 44, SCIENCE. X

Visiting Lecturer: Comparative anatomy; vertebrate zoology, Morphology, and Ecology. Available, September (1950). Box 41, SCIENCE. X

POSTIONS OPEN

Positions Open:
(a) **Professor of pharmacology**; Ph.D. or M.D.; woman eligible; eastern medical college; $6500–$8000. (b) **Biochemist**; Ph.D.; preferably one who has obtained his doctorate within the past five years; advantageous if interested in endocrinology, metabolism and enzyme chemistry; should have definite interest in academic research; research division, university medical school. (c) **Bacteriologist** qualified in immunology, preferably Ph.D. experienced in control of biologicals, antibiotics and germicides desirable; administrative ability required; one of leading pharmaceutical industries. (d) **Assistant director of laboratories**; 300-bed general hospital; administrative ability with background in one of sciences, preferably chemistry, required; $5000–$7000. (e) **Biochemist** qualified to direct division large general hospital; Gulf Coast; $6000. S2-4 Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

Personnel Placement

POSTIONS OPEN

Pharmacologist or Physiologist: Recent Ph.D. or experienced M.S. as assistant to pharmacologist for pharmacodynamic research in growing pharmaceutical company in Metropolitan New York. Give details in first letter. All replies confidential. Box 18, SCIENCE. 2/24

Zoologist: Instructor for General and Invertebrate Zoology, Entomology, in eastern Canadian University with strong interest in Limnological Research, September first. Preferably recent Ph.D. with experience in taxonomy of fresh-water zooplankton. Salary commensurate with qualifications. Box 36, SCIENCE. 2/24

The Market Place

CHARGES and REQUIREMENTS for "MARKET PLACE" Ads

1. Rate: 20¢ per word for *classified* ads, minimum charge $5.00 for each insertion. Such ads are set in uniform style, without display; the first word, only, in bold face type.
For *display* ads, using type larger or of a different style than the uniform classified settings, and entirely enclosed with separate rules, rates are as follows:

Single insertion	$16.00 per inch
7 times in 1 year	14.50 per inch
13 times in 1 year	13.00 per inch
26 times in 1 year	11.50 per inch
52 times in 1 year	10.00 per inch

2. Payment: For all *classified* ads, payment in advance is required, before insertion can be made. Such advance remittances should be made payable to SCIENCE, and forwarded with advertising "copy" instructions.
For *display* advertisers, monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

3. Closing Date: Classified advertisements must be received by SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

For proof service on display ads complete "copy" instructions must reach the publication offices of SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., not later than 4 weeks preceding date of publication.

BOOKS

The Market Place

PROFESSIONAL SERVICES

SPECIAL GLASS APPARATUS

Our glass blowing department is available for special scientific and technical glass apparatus made to specifications and drawings. Inquiries invited. Estimates furnished.

E. MACHLETT & SON
218 East 23rd St. New York 10, N. Y.

SUPPLIES AND EQUIPMENT

✓ CHECK LIST CARGILLE PRODUCTS FOR CHEMISTS

TRANSPARENT PLASTIC BOXES:
For keeping samples, specimens and small parts in order; completely visible. 5 sizes 401

BOILING STONES:
Effective anti-bumping agent for overheated liquids. Speeds distillations, yields sharper fractions. Samples on request 402

VISCOSITY TUBES:
Matched for the Air-Bubble Method of comparing viscosities. Widely used in the Varnish Industry 403

Just specify code number.

R. P. CARGILLE
118 Liberty St., New York 6, N. Y.

GLYCOCYAMINE—Hydroxyproline, L-Methionine
• AMINO ACIDS • BIOCHEMICALS
• PRE-MIXED MICROBIOLOGICAL ASSAY MEDIA
H. M. CHEMICAL COMPANY, LTD.
144 North Hayworth Avenue Los Angeles 36, California

FIALA OUTFITS, INC.
10 WARREN STREET, NEW YORK 7, N.Y.
SCIENTIFIC INSTRUMENTS & FIELD EQUIPMENT
FOR GEOLOGISTS, SURVEYORS, ENGINEERS & EXPLORERS
Every necessity suggested & supplied as proved by experience in the field—from Poles to the Equator
FIALA OUTFITS NEW YORK
INCORPORATED 1922

STAINS
STARKMAN Biological Laboratory
• RARE
• COMMON
Price list on Request
• 461 Bloor St., W. Toronto, Canada

YOUR AD HERE WILL PRODUCE RESULTS
Plan NOW for MORE SALES in 1950 . . .
See "Charges & Requirements", or write for Rate Card 26 Today.

The Market Place

SUPPLIES AND EQUIPMENT

for
• MICROSCOPES
• MICROTOMES
• REFRACTOMETERS
Equipment for Photomicrography
Write to
ERIC SOBOTKA CO. • 102 West 42d Street New York 18, N. Y.

• HYPOPHYSECTOMIZED RATS
Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc. • 808 E. 58th St. Chicago 37, Ill.

NEW—IMPORTANT **BVL AGAR MEDIA TABLETS**
SAVE TIME and EXPENSE—AVOID DRUDGERY
Simply add water and sterilize—Corn Digest Dextrose, Dahlia Dextrose, Lima Bean Digest Dextrose, Oat Digest Dextrose, Pea Digest Dextrose, Potato, etc., in Lots of 100 and 1000 Tablets and Plain Agar in Lots of 250 and 1000 Tablets.
BEN VENUE LABORATORIES. Inc. • **Bedford, Ohio**

SNOOPERSCOPE TUBES—Permits infrared vision. Tube and complete instructions $14.95. Limited Quantities. PRECISE MEASUREMENTS CO., 942 Kings Highway, Brooklyn 23, N. Y. X

QUARTZWARE
for laboratory and industry
A complete line of standard laboratory ware
Also custom fabricating to meet your requirements.
Write for particulars.
THE PANRAY CORP.
340 Canal Street, New York 13, N. Y.

All Amino Acids (natural, synthetic, unnatural), Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.
BIOS LABORATORIES, INC. 17 West 60th Street, New York 23, N. Y.

LABORATORY ANIMALS
• Clean healthy well-fed animals
• Guaranteed suitable for your needs.
Reasonably priced—Dependable service

DOGS	RATS	RABBITS
CATS	PIGEONS	HAMSTERS
MICE	POULTRY	GUINEA PIGS

JOHN C. LANDIS • Hagerstown, Md.

ANIMAL CAGES AND ACCESSORY EQUIPMENT
ORDERS NOW ACCEPTED FOR EARLY DELIVERY
HOELTGE BROS., Inc.
1919 Gest St. **Cincinnati 4, Ohio**
Write for Illustrated brochure

Yesterday's tissues completely processed, stained . . . ready for pathologic diagnosis *this morning* . . . within short *hours*, not *days*, of surgery. Normal, day-in, day-out schedule, which **Autotechnicon** maintains consistently, for it knows no human fallibility, no human fatigue. Dispenses with tedious hand methods, with an overall gain in quality. The surgeon, as well as the pathologist, will find our brochure describing **Autotechnicon** of great interest. It is available on request.

Autotechnicon

Trade Mark Registered U. S. Patent Off.

automatic fixation, dehydration
washing, infiltration, staining

THE TECHNICON COMPANY
215 East 149th Street • New York 51, N. Y.

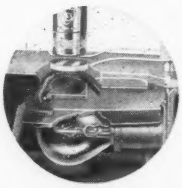
New Improved

SPENCER SCHOLAR'S MICROSCOPE

BETTER 4 WAYS FOR TEACHING

Stage Temperature Favors Most Living Material

New heat-absorbing glass and baffle plate prevent overheating.

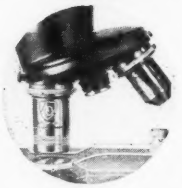


Saves Time Teaching Science

So easy to learn and to use...more time is free for teaching *Science*. Simple controls permit more rapid operation.

A Precision Scientific Instrument

Standard quality Spencer trademarked optics. Precise all-metal bearing surfaces.



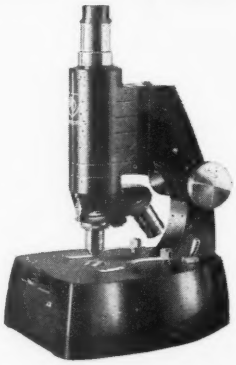
Low Cost to Buy and Maintain

Locked-in parts reduce maintenance costs-'Spring loaded' focusing mechanism protects slides.

PRICE

$99.50

(For 100X-430X model as illustrated)



● Spencer No. 78 Scholar's Microscope, with built-in factory-focused light source furnishes constant, uniform illumination and consequently better optical performance. Time-consuming and frequently faulty sub-stage adjustments are eliminated. Reversed position of microscope arm offers clear view of stage, objectives, and diaphragm openings. Low over-all height increases comfort. Time-saving single control provides rapid yet critical focusing. Ask your AO Distributor to show you the No. 78 Microscope... or write for catalog M153 to Dept. B4.

American Optical
COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK

Makers of Precision Optical Instruments for over 100 Years